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ABSTRACT

Five of these eleven units describe methods elementary school students can use when studying soil characteristics. Soil nitrogen and water holding capacity tests are included with two techniques for measuring soil pH. Survey methods for soil organisms are suggested. The remaining pamphlets describe diverse activities associated with field environmental studies. Techniques for measuring slopes, drawing profiles and contours and for calculating water-shed run off are detailed and illustrated. Detailed studies of a single tree are suggested to make children aware of interdependence in nature. An outdoor activity investigating many individuals of one plant species designed to stress individual variation is described. Background information for the teacher, and instructions for making some of the apparatus, are included. This work was prepared under an ESEA Title III contract. (AL)

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SOIL SAMPLING

Acidity/Alkalinity

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Environmental Science Center   Early Trial Edition

SOIL SAMPLING

Acidity - Alkalinity

It is important that youngsters are at an early age exposed in a systematic way to studies of their environment and its components. Further, the way in which they first confront their surroundings is critical in terms of later learnings and the development of inquiry techniques applicable to new and different areas of study, both without and within science.

Many opportunities to begin to develop techniques of inquiry using the environmental sciences as a content background exist in and around your schoolgrounds. This lesson describes one such activity. Equipment needs are minimal; the time required will depend upon student interest and your schedule. The method can be employed for tests of any kind of soil.

MATERIALS

Item	Description	Source	Quantity
cups	paper, drinking	school, grocery	1/student
spoons	plastic picnic type	grocery	1/student
tongue depressors		school, drugstore	1/student
litmus paper	blue and red	school, supply house	2 of each color/ student
glass slides	1 x 3 microscope type	school, supply house	1/student
distilled water		grocery	1 cup
paper	1" ruled graph, or plain paper	school	1/student

BACKGROUND

The distribution and appearance of plants is to a large degree controlled by the type and characteristics of the soil in which they are found. This is to say that certain plants are found in certain places because, in part, the soil contains those things necessary for the plant to grow. Not all plants have the same requirements for growth. This becomes apparent as one begins to identify certain plants with certain areas. For example, one would only expect to find cattails around moist areas or ponds where the soil is capable of holding relatively large amounts of water. Conversely, cacti are adapted to dry soil and are structured so as to conserve water. These are examples of the plant-water relationship which in part is determined by soil type. It is the most essential determinant of plant distribution but by no means the only one.

The availability of certain plant nutrients, sunlight and temperature variation, are several other factors which determine plant distribution. No one factor alone accounts for distribution patterns, rather several factors operating at once upon the plant determine whether or not it could survive in a given area.

Since it is impossible to investigate all of the above-mentioned environmental factors at one time, this lesson will concentrate on the development of one technique for studying something about the acidity or alkalinity of soil. The acid content of soil is easily checked by the use of litmus paper. The paper is available in strips of two colors. Red strips turn blue if the soil (or other material being tested) is neutral or alkaline while blue strips turn pink if exposed to acidic material. The children need only know that these strips are used to detect a certain soil property. The important idea is whether or not this property is uniform across a sample area.

The activity can be done at any time of the year, but most easily in the fall or spring. It may be inserted in a unit on plant associations, conservation, or any others dealing with the natural environment.

The children will learn a simple method for the systematic sampling of a plot of ground. They will collect and record data resulting from soil tests and observations. Finally, they will construct maps of their plot and draw some conclusions based upon tests and observations of soil samples. To as great an extent as possible, permit the children the freedom to make their own discoveries, arrive at conclusions, and determine the next phase of their investigations. While some structure necessarily must be imposed by you, actively involving the children in the procedural aspects of the lesson may make it more productive for both you and your students.

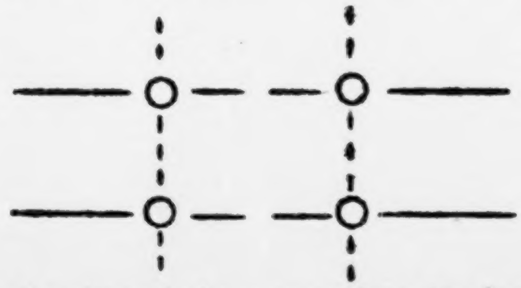
PROCEDURE

Organize the children for a field trip around the schoolyard. They should be equipped with pencils and paper or small notebooks. Gather together the spoons, paper cups and tongue depressors plus some ordinary crayons for marking purposes. Bring these materials with you.

The trip should be pointed toward an area of lawn somewhere near or on the schoolgrounds. Before the trip you may wish to identify an area of lawn where the grass is not uniform in color or texture and one in which it might be possible to stake semi-permanent markers -- the tongue depressors. The area should be about the size of a classroom.

When the site has been located, ask the class to begin observing and describing what they see. Now most of them will not perceive much challenge in an ordinary lawn. Actually, the challenge resides within their ability to make observations rather than in the lawn itself. When you determine they have made fairly complete descriptions, bring them together to share their observations. Discuss what they see and then ask if they can think of any reasons for differences among some of their observations. You may obtain a variety of answers to this question. Rainfall, "bugs", different kinds of grass, weeds, poor soil, and lack of fertilizer are all possible explanations. After a number of ideas have been presented, inquire if it is possible to investigate any of them in some detail. When this question has been discussed adequately, you may suggest that one way to begin might be to look at the soil. How could they find out more about the soil? None of the responses may have anything to do with the soil tests they will eventually perform, but you may be able to lead them to its significance after they examine some of it more closely in the classroom.

If they are to look at the soil, samples of it must be collected. They should be made aware of the necessity for collecting in some systematic fashion over the whole area. Also, if they will be doing other kinds of tests, they will each want to return to about the same area the next time. One way to systematize the collecting would be to arrange the students in six rows of five students each. They may space themselves over the site by extending their arms in such a way that only finger tips touch in any direction they turn. The patch of ground directly under their feet then becomes their sample area. Observations of the grass may be made and recorded. At this time the students should note their position relative to other students around them so that maps may be made upon their return to class.



When they understand this spacing technique, provide each with a cup, a spoon, and tongue depressor. Have each scoop up several spoonsful of soil and place them in the cups. Cups should be marked with names. Depressors should also be marked (preferably with wax crayons) and pushed into the ground so that each patch is identified.

Return to the classroom with the materials. Have the students sprinkle the samples onto some paper on their desks. Each should observe their samples and record observations. Things to look for might be color, texture, odor or anything else of interest. You might then inquire if there is anything about the soil which might not be readily observable with the eyes. If so, have the class suggest what some of these things might be. This line of questioning can then lead into the soil test activity.

Distribute four pieces of moistened litmus paper (two red, two blue) to each student. If possible, distilled water should be used for the moistening, since tap water may contain some minerals which cause changes in paper color. Provide each child with a microscope slide and direct them to place one blue and one red strip of paper on the slide about two inches apart. Next, they should put a sample of soil -- about one half teaspoon -- on each paper strip. If the soil is quite dry, it may be moistened with several drops of distilled water.

Questions will arise as to what kind of paper they have been given. You may wish to describe it as paper containing certain chemicals which indicate something about the chemical properties of their soil. You need not pursue your explanation in any great detail, however.

After several minutes, ask the children to lift their slides and observe the color of the paper through the underside of the glass. What do they see? Are the colors still the same? What do they have to use for comparison purposes?

Before further discussion, distribute the graph paper or rule plain paper into one inch square units. Each square should be marked with a child's name according to his position in the field. You might draw the grid on the board for the children to copy. When this is completed, then the results of each test should be placed in the appropriate square.

Now that they have derived a pattern for the site, have them examine it in terms of the descriptions made of the lawn. If all of the test results were the same, what might be concluded about the relationship between this factor and the appearance of the lawn? If different results were obtained, can they be correlated with descriptions of the lawn? How much ought to be concluded on the basis of these tests alone? What might the next step be? Should more tests be made to verify these results or should other factors now be investigated?

ESC Field Activities

TESTING FOR SOIL NITROGEN CONTENT[2]

General

Nitrogen is an element which stimulates above-ground growth and produces the rich green color characteristic of a healthy plant. The utilization of potash, phosphorus and other nutrients is stimulated by the presence of nitrogen. An excess, however, can produce harmful effects such as delayed maturity or ripening and decreased resistance to disease.

Some investigators indicate that the presence of excess nitrates in foods may be detrimental to health. This harmful effect is caused by the reduction of nitrates to nitrites by bacteria. Nitrites in the bloodstream are poisonous and may cause abortion in cattle, hay poisoning, grass tetany or reduction of hemoglobin content in blood.

Soils ordinarily contain about 0.1% nitrogen and a proportionately smaller percentage of available nitrates. Unavoidable loss due to the leaching action of water hastens the exhaustion considerably. Sandy soils, particularly, are low in nitrogen due to the rapid rate at which decomposition of organic matter and the leaching of resulting soluble products takes place.

Organic matter contains almost all the soil nitrogen. In this form, the nitrogen is not available for use by plants and must be first transformed by soil bacteria to water-soluble nitrates or ammonia. Plants may then absorb the nitrates through their root systems.

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Soil Extract Preparation (LaMotte)

1. Place 14 cc Universal Extracting Solution (LaMotte) into an extraction tube.

2. Add about 2 g soil to the tube containing the solution described in #1 above.

3. Stopper the tube and shake for one minute.

4. Filter the soil suspension through filter paper into a clean tube.

Nitrate Nitrogen Soil Test

1. Transfer 1 cc of the soil filtrate to one of the depressions on a spot plate. [A small test tube will also suffice.]

2. Add 10 drops of nitrate reagent #1.

3. Add about 0.5 g of nitrate reagent #2 and stir thoroughly.

4. After five minutes, compare the resulting pink color to a nitrate nitrogen color chart.

Ammonia Nitrogen Soil Test

1. Transfer 4 drops of the soil extract to a depression on your spot plate.

2. Add 1 drop of the ammonia nitrogen test solution and stir.

3. Wait 1 minute and compare the resultant yellow or orange color to the color chart.

Nitrite Nitrogen Soil Test

1. Transfer 5 drops of the soil extract to a spot plate or small test tube.

2. Add 1 drop of the nitrite test solution #1.

3. Add 1 drop of the nitrite test solution #2 and stir.

4. Add 2 drops of nitrite test solution #3, stir and compare the resultant color to the color chart. NOTE: If the deepest shade of orange represented on the chart is produced, the test should be repeated. Transfer 1 drop of the soil extract to the spot plate, dilute it with 4 drops of the extracting liquid and repeat the test as directed above. The amount of nitrite nitrogen corresponding to the color thus produced must be multiplied by 5 to obtain the amount in terms of parts per million of nitrites in the soil.

Interpretation

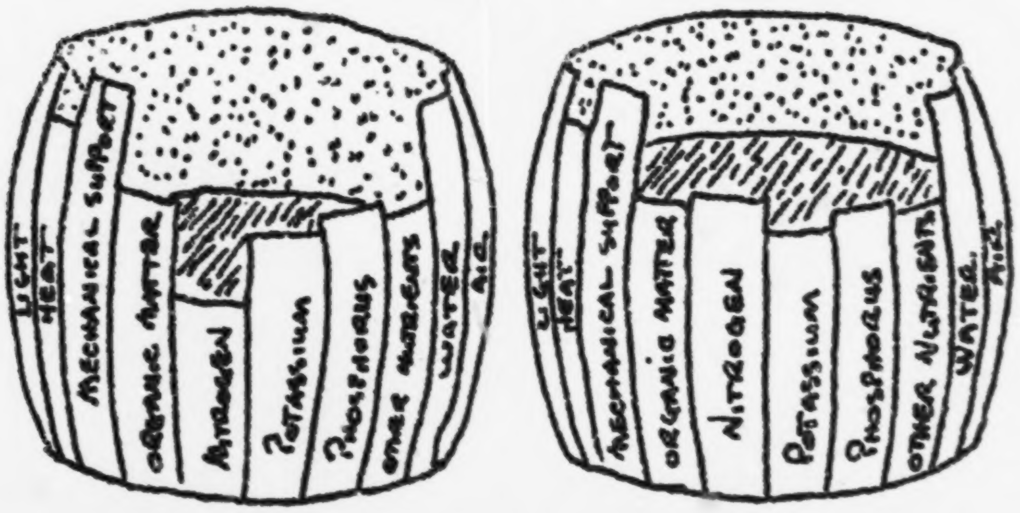
LIGHT
HEAT
MECHANICAL SUPPORT
ORGANIC MATTER
NITROGEN
POTASSIUM
PHOSPHORUS
OTHER NUTRIENTS
WATER
AIR
LIGHT
HEAT
MECHANICAL SUPPORT
ORGANIC MATTER
NITROGEN
POTASSIUM
PHOSPHORUS
OTHER NUTRIENTS
WATER
AIR

Figure 1. A simplified diagram to illustrate the principle of limiting factors. The level of water in the barrels above represents the level of soil productivity. On the left, nitrogen is represented as being the factor that is most limiting. Even though the other factors are more than adequate, productivity can be no more than that allowed by the nitrogen available. Addition of nitrogen will increase productivity until another factor becomes limiting.[1]

A low test for ammonia is to be expected in a fertile soil, unless there has been a recent application of nitrogenous fertilizer in forms other than the nitrate. The rate of ammonia disappearance from soil in such cases is an indication of the transformation of ammonia into more available nitrate compounds.

In forest soils, especially in the humus layers, ammonia is the most abundant available form of nitrogen. These organic horizons may produce very high ammonia nitrogen concentrations if there is a satisfactory rate of nitrogen transformation.

Nitrites are formed as an intermediate step in the production of nitrates in soils. In adequately drained and aerated soils they are found only in very small amounts. A high test for nitrite nitrogen indicates a

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soil condition which may be unfavorable to the formation of nitrates and toxic to plants.

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[1] Buckman, H.O. and N.C. Brady. 1967. The nature and properties of soils. The Macmillan Co.: New York.

[2] _____. The LaMotte soil handbook. LaMotte Chemical Products Co.: Chestertown,Maryland.

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SOIL SAMPLING

Water Holding Capacity

It is important that youngsters are exposed in a systematic way to studies of their environment and its components at an early age. Further, the way in which they first confront their surroundings is critical in terms of later learnings and the development of inquiry techniques applicable to new and different areas of study, both without and within science.

Many opportunities to begin to develop techniques of inquiry using the environmental sciences as a content background exist in and around your school grounds. This lesson describes one such activity. Equipment needs are minimal; the time required will depend upon student interest and your schedule. The method can be employed for tests of any kind of soil.

MATERIALS

Item	Description	Source	Quantity
tin cans	concentrated juice, 6 oz	home	1/student
filter paper	5-6" in diameter	school, supply house	1/student
rubber bands		school	1/student
plastic plant trays or other	shallow containers	school, home	1/2 dozen
balances	Harvard triple beam		1/2 dozen
baggies or glad bags		grocery	1/student
spoons	plastic picnic type	grocery	1/student

BACKGROUND

The distribution and appearance of plants is to a large degree controlled by the type and characteristics of the soil in which they are found. This is to say that certain plants are found in certain places because, in part, the soil contains those things necessary for the plant to grow. Not all plants have the same requirements for growth. This becomes apparent as one begins to identify certain plants with certain areas. For example, one would only expect to find cattails around moist areas or ponds where the soil is capable of holding relatively large amounts of water. Conversely, cacti are adapted to dry soil and structured so as to conserve water.

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These are examples of the plant-water relationship which, in part, is determined by soil types. It is the most essential determinant of plant distribution, but by no means the only one.

As was mentioned, soil-water relationships are the most significant determinants of plant distribution. Soils differ in their capacity to hold water. It takes a great deal of water to thoroughly wet heavy or clay soils, but light or sandy soils are saturated by relatively little moisture.

These ideas are of extreme importance to the soil conservationist and the farmer. But, they should also be investigated and understood by students since soil loss through erosion will have an enormous impact on our economy in the near future.

The activity presented in this lesson describes a procedure for measuring the water-holding capacity of soil. Children will obtain soil samples from various sites on or around their school grounds. As part of their collecting experiences they will examine and describe their soil samples. After they investigate the water-holding properties of the various soils collected, they will relate their measurements to describe soil types.

PROCEDURE

Before organizing a field trip with your class, examine the school grounds to determine something of the nature of the soil. Look for areas where leaves have fallen forming a layer 1/2 to 1 inch over the soil. Find a nearby field where weeds have overgrown the area. Select a spot where the soil has been mixed with sand, and one which appears to be primarily clay in type. Most of these soil differences may be recognized by variation in color. Not all types need to be found. It would be of value, however, to identify contrasting types so that students see differences.

At an appropriate time of the school year (fall or spring) request the children to begin saving frozen juice cans. Have them remove the usually unopened end at home and then bring them to school when you are about to begin the lesson. Assemble the other materials in the meantime.

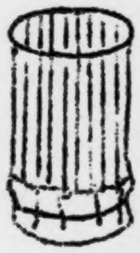
Organize the field trip and provide each child with a plastic spoon and bag. Once outdoors, take them to the predetermined collecting areas and have them examine the soil. They should observe color, texture, odor, particle size, and anything else of significance.

If the class is divided into teams each team may observe different soil then share their observations with other teams. Try to avoid stating that differences do exist; permit this conclusion to arise from student observation and discussion.

After comparisons have been made, you will want the students to speculate about the significance of their observations. Various soils differ in many properties. Of what importance, then, are these differences? Some possible answers might relate to the kinds of plants capable of growing in that soil, "richness" or "poorness" in soil quality and perhaps the notion that the soils are made of different things. Perhaps no one will suggest that different soils are capable of holding differing amounts of water. At this point, it is not important for them to arrive at this conclusion since it will be investigated upon their return to class.

When the discussion is concluded, direct the groups or individuals to obtain approximately a half a bag of soil to take back to class. Use the spoons and plastic bags for collecting. Upon returning to the classroom, the soil may be emptied from the bags onto paper toweling or several sheets of writing paper. Students should place their names on the paper and record descriptions of their samples. Set aside the soil for several days. Make certain the samples do not mix.

When all samples appear to be dry (this can be hastened through oven drying) hand out filter paper, rubber bands, and fruit juice cans. Arrange the balances around the room creating several weighing stations. Students should secure the piece of filter paper over one end of the can with a rubber band as follows:



Each of the cans should be weighed and the weight recorded. When this is done, direct each student to fill about 1/2 of his container with his dried soil sample. The soil and can should then be weighed. Record this weight.

Place water in the shallow trays and immerse the lower half of the samples in the water. Let them stand overnight. On the following day, remove the cans from the tray and allow them to drain for about one half hour. Draining may be accomplished by emptying the remaining water in the tray and placing rulers across the tray upon which to stand the dripping cans.

Before proceeding with the draining you may want the students to first make observations of the soaked cans of soil. Did the water enter the soil? Did its level rise above that of the soil? How can they account for this? What are some of the properties of the filter paper?

Excess moisture on the can must be thoroughly removed before the can is weighed. When this is done, ask the students to make predictions about the new weight of the can. Next, have them weigh the entire unit and compare the new weight with the old weight. How do they explain the difference in weight?

They will now need a means for determining the percent moisture-holding capacity. Why can't "raw" weights be used? The formula for calculating the percent is relatively simple as shown below:

$$\text{Percent moisture-holding capacity} = \frac{\text{Gain in weight due to immersion}}{\text{weight of dried soil}} \times 100$$

When students have completed their calculations, collect their data and place it on the board for the class to discuss. You may make a simple chart based on the descriptions of the samples tested as follows:

	Dark Soil	Sandy Soil	Light, Fine Soil
Student			
1			
2			
3			
4			
5			
6			
7			
8			

Each student should determine which description best fits his soil. His data is then entered in the appropriate column. After all of the results are reported, some observations may be made. Did students with similar soil obtain similar results? Which type absorbed the most water? Did any sample hold more than its initial dry weight? That is, is any soil capable of holding more than its own weight in water? How may this, in turn, be related to the kinds of vegetation that soil supports?

Which type might most easily erode? During a downpour, on which type of soil might water most easily run-off? What are some ways of preventing this run-off?

The student's chart can be used as a "model" for moisture-holding capacity. Given adequate soil type descriptions and the data in the chart, unknown samples of soil can be compared with the chart descriptions and their water-holding capacity predicted on the basis of their similarity of the known types. Suggest that the students collect a variety of soil from around their homes or elsewhere, bring them to class, compare them with those previously tested, predict a water-holding capacity, and then verify their predictions by performing the above procedures. How useful is their established data for making predictions about unknown samples? Can the model data be improved and refined through the collection of additional data? What are some of the shortcomings of the original data if it is viewed as a model system?

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ESC Field Activities

THE SOIL ACIDITY TEST[2]

General

A pH test is a measurement of the acidity or alkalinity of soil and is essential for determining lime requirements. Also, due to the fact that plants vary in their preference for soils of differing pH, a test of this sort enables one to better understand some of the factors influencing plant distribution in a natural situation and aids the farmer in the proper care and planting of crops.

The Soil Sample

Samples may be taken with a soil sampling tube or by means of a trowel. Soil collected should be taken from top to bottom of the plant rooting space (about 7 in), allowed to dry in the air and then shaken through a wire grate of about the same mesh as a window screen. Samples can be conveniently stored in plastic bags until testing. Be sure to map the area sampled and number the samples to correspond with sample sites on your map.

Test Procedure

1. Fill test tube 1/3 full of soil, add distilled water until nearly full and shake well.
2. Add spatula (about 1.5 g) full of barium sulfate, shake well and set aside to settle. (The $BaSO_4$ will cause the soil suspension to settle rapidly.)
3. Transfer to a spot plate sufficient soil extract to nearly fill one of the depressions. Use individual pipettes for separate transfers to avoid contamination.
4. To this sample add one drop of LaMotte Duplex Indicator and compare to the color chart. (Other universal indicators can also be used to establish the approximate pH.)

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5. The universal pH indicator will give you the approximate range of the soil pH. Based on the results of the test in #4, you can now select the indicator whose range most closely compliments the preliminary test range. The following can be used: BROMCRESOL GREEN (3.8 to 5.4); CHLORPHENOL RED (5.0 to 6.6); BROMTHYMOL BLUE (6.0 to 7.6); PHENOL RED (6.6 to 8.2); or some of the narrow range pH test paper strips.

Interpretation

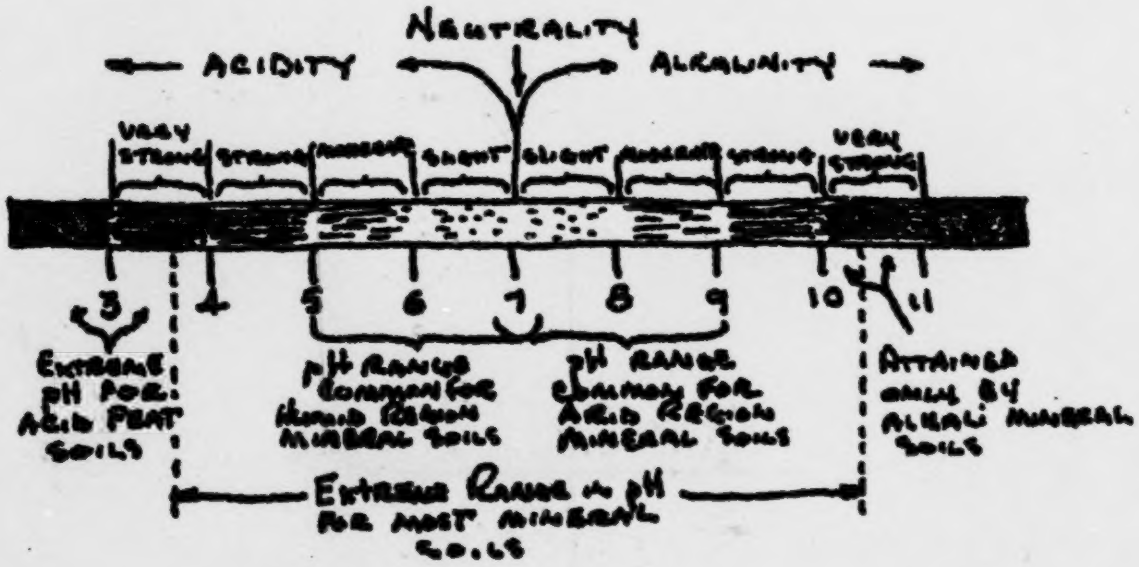
NEUTRALITY
ACIDITY
ALKALINITY
VERY STRONG
STRONG
MEDIUM
SLIGHT
SLIGHT
MEDIUM
STRONG
VERY STRONG
3
4
5
6
7
8
9
10
11
EXTREME pH FOR ACID PEAT SOILS
pH RANGE COMMON FOR HUMID REGION MINERAL SOILS
pH RANGE COMMON FOR ARID REGION MINERAL SOILS
ATTAINED ONLY BY ALKALI MINERAL SOILS
EXTREME RANGE IN pH FOR MOST MINERAL SOILS

Figure 1. Diagram showing the extreme range in pH for most mineral soils and the range commonly found in humid-region and arid-region soils respectively. The maximum alkalinity for alkali soils is also indicated, as well as the minimum pH likely to be encountered in very acid peat soils.[1]

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[1] Buckman, H.O. and N.C. Brady. 1967. The nature and properties of soils. The Macmillan Co: New York.

[2] _____. The LaMotte soil handbook. LaMotte Chemical Products Co: Chestertown, Maryland.

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ESC Field Activities

CALCULATING THE RUNOFF FROM A WATERSHED[1]

Steps

1. Determine rainfall frequency.
2. Calculate runoff.
3. Determine watershed runoff.

Factors

1. Slope
2. Ability of the soil to absorb water
3. The vegetal cover
4. Amount of water stored on the surface
5. Rate and amount of rainfall

Determining Rainfall Frequency

In determining rainfall frequencies, the probable amount and rate of rainfall is used. The maximal amounts are determined on the basis of 50-year, 25-year and 10-year storms which can be expected to occur within the designated interval.

Calculating Runoff

The runoff rate is measured in cubic feet per second (cfs). A reasonable estimate of surface runoff can be obtained by the following method. This technique is used successfully by the Soil Conservation Service in the Corn Belt States.

1. Use Table 1 to determine the relief for the average slope.
2. Use the soil infiltration for average loam.
3. Use the vegetal cover (acreage x score index).
4. Use surface storage for drainage system.
5. Add numbers 1 - 4 to determine the summation of watershed characteristics (Ew).

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[1] Foster, A.B. 1964. Approved practices in soil conservation. Interstate Printers and Publishers, Inc. Danville, Illinois.

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6. To determine the maximum probable runoff for 10-year or 50-year storms, match the acreage and Ew columns to the nearest value and read the runoff at their intersection. (Tables 3 and 4).

7. For areas where the rainfall factor is not 1.0, multiply the value in # 6 above by the correction factor. You now have the maximum probable runoff by inserting the actual amount of rainfall for the storm.

Table 1. Runoff-Producing Characteristics of a Watershed

DESIGNATION OF WATERSHED CHARACTERISTICS	100 EXTREME	75 HIGH	50 NORMAL	25 LOW
RELIEF	(40) Steep, rugged terrain with average slopes generally above 30%	(30) Hilly, with average slopes of 10 to 30%	(20) Rolling, with average slopes of 10 to 30%	(10) Relatively flat land, with average slopes of 0 to 5%
SOIL INFILTRATION	(20) No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity.	(15) Slow to take up water; clay or other soil of low infiltration capacity, such as heavy gumbo	(10) Normal; deep loam with infiltration about equal to that of typical prairie soil	(5) High; deep sand or other soil that takes up water readily and rapidly
VEGETAL COVER	(20) No effective plant cover; bare or very sparse cover	(15) Poor to fair; clean-cultivated crops or poor natural cover; less than 10% of drainage area under good cover	(10) Fair to good; about 50% of drainage area in good grassland, woodland, or equivalent cover; not more than 50% of area in clean-cultivated crops	(5) Good to excellent with about 90% of drainage area in good grassland, woodland, or equivalent cover
SURFACE STORAGE	(20) Negligible; surface depressions few and shallow; drainage-ways steep and small; no ponds or marshes	(15) Low; well-defined system of small drainage-ways; no ponds or marshes	(10) Normal; considerable surface-depression storage; drainage system similar to that of typical prairie lands; lakes, ponds and marshes less than 2% of drainage area	(5) High; surface-depression storage high; drainage system not sharply defined; large flood-plain storage or a large number of lakes, ponds or marshes

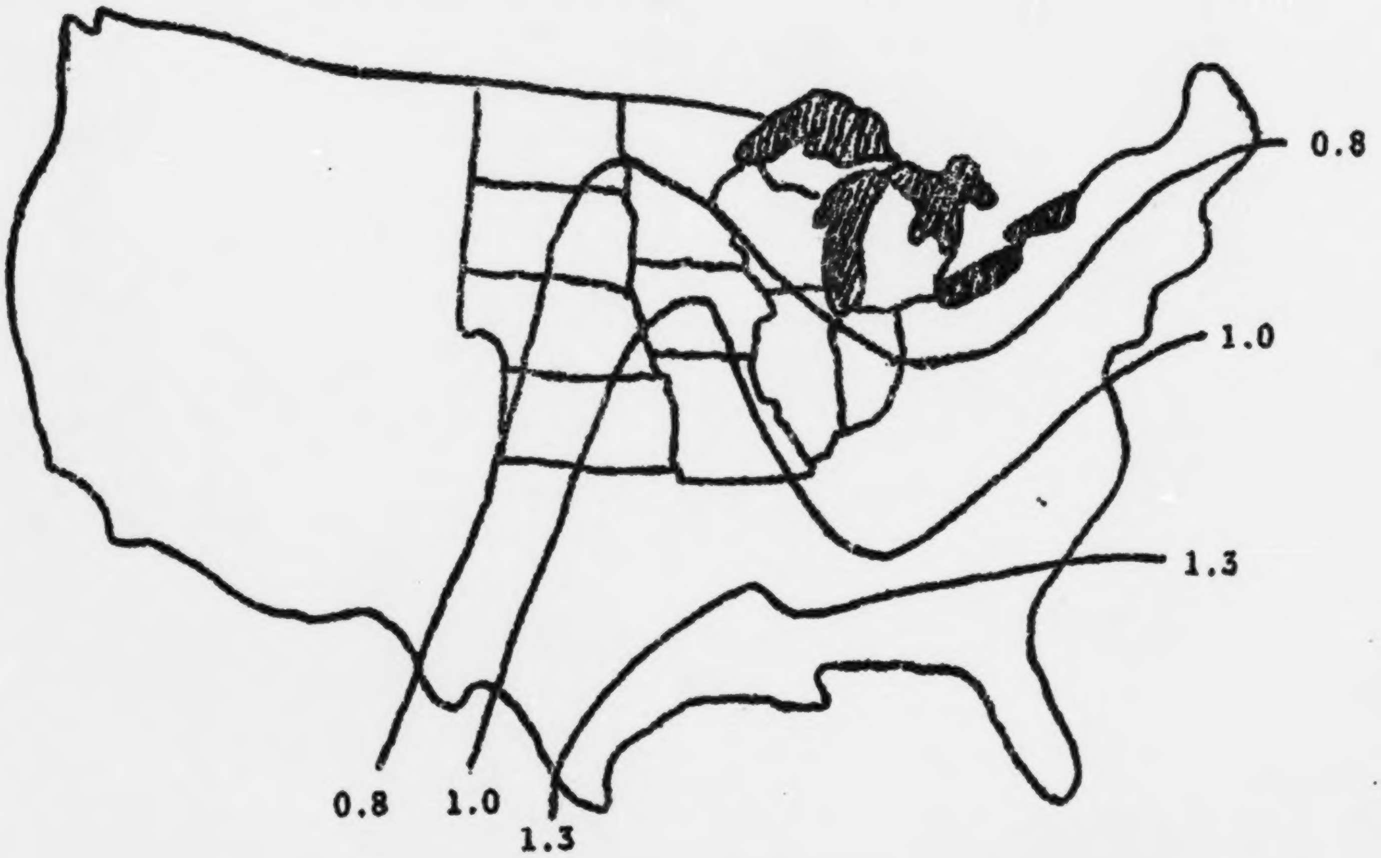
0.8
1.0
1.3
0.8
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Figure 1. Rainfall factors to be used in determining runoff from watersheds in the midwest.

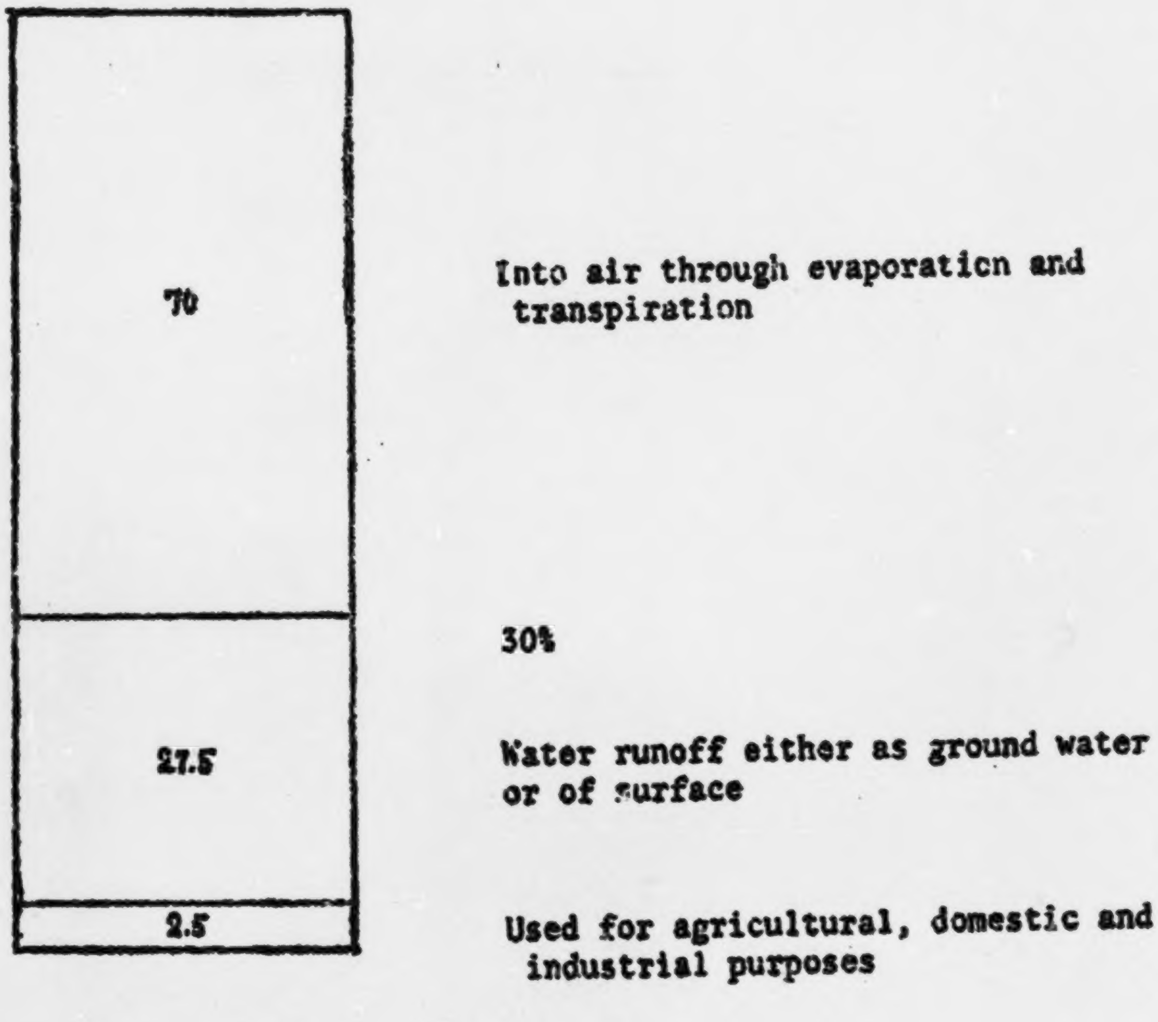

Figure 2. What happens to our rainfall?

Table 2. Runoff chart based on
10 years frequency and rainfall factor of 1.0.

Drainage Area in Acres	Watershed Characteristics										
	30	35	40	45	50	55	60	65	70	75	85
	P_{10} = Cubic Feet Per Second										
4	5	7	8	9	10	11	13	15	17	20	24
6	6	8	10	11	13	16	18	21	24	28	34
8	7	9	12	13	17	20	24	28	32	37	44
10	8	10	14	16	21	25	30	35	40	46	53
12	9	11	16	19	24	29	35	41	48	54	62
14	10	13	18	22	28	33	40	47	55	62	71
16	11	15	20	25	31	38	45	53	62	70	80
18	12	17	22	28	34	42	50	59	79	78	89
20	14	19	24	31	38	46	55	65	76	86	98
25	16	22	28	36	46	55	66	78	90	103	118
30	18	25	32	42	53	64	77	91	105	120	139
35	20	28	36	47	60	73	87	104	120	137	159
40	22	32	41	53	68	82	98	117	135	154	179
45	24	36	46	59	76	91	109	130	150	171	200
50	26	40	51	65	83	100	119	142	165	166	220
60	30	45	59	76	97	117	139	165	193	221	259
70	34	50	66	87	110	133	159	188	221	253	298
80	38	55	74	97	123	149	179	211	248	285	338
90	42	60	81	107	136	166	199	234	274	317	378
100	46	65	88	117	150	182	218	256	300	348	418
120	53	75	102	135	175	213	256	300		410	487
140	60	85	116	154	200	244	293	344	401	471	556
160	67	95	129	172	224	275	329	388	451	523	625
180	73	105	142	190	248	305	364	432	500	585	694
200	79	115	155	207	271	334	398	476	550	640	764
220	85	124	168	224	294	363	432	516	598	693	832
240	91	132	180	241	317	392	464	556	645	746	899
260	97	141	192	257	340	421	496	595	691	799	964
280	102	149	204	273	362	450	528	634	736	852	1028
300	108	158	216	289	384	480	560	672	781	905	1090
320	114	167	228	305	407	505	591	709	824	956	1150
340	119	175	240	321	429	530	623	746	867	1007	1210
360	124	184	253	337	451	555	654	723	909	1058	1270
380	129	192	265	355	473	580	684	820	952	1109	1330
400	135	200	277	371	494	605	713	856	994	1160	1390
420	141	208	288	386	515	629	741	891	1035	1209	
440	146	216	299	401	535	653	769	926	1076	1257	
460	151	224	310	416	554	677	797	961	1117	1303	
480	156	232	321	432	572	700	825	996	1158	1348	
500	161	239	332	447	590	723	853	1030	1199	1392	
520	166	246	342	462	607	746	881	1064	1238	1435	
540	171	253	352	476	624	769	909	1098	1277	1478	
560	176	260	362	490	641	791	937	1131		1521	
580	181	267	372	504	658	813	965	1164	1350	1563	
600	185	274	382	518	675	835	993	1197		1605	

Table 3. Runoff chart based on
50 years frequency and rainfall factor of 1.0.

Drainage	Watershed Characteristics												
Area in	25	30	35	40	45	50	55	60	65	70	75	85	100
Acres	P_{50} = Cubic Feet Per Second												
4	5	7	10	11	13	14	15	18	21	24	28	34	36
6	6	8	11	14	15	18	23	25	30	34	40	48	51
8	7	10	13	17	18	24	28	34	40	45	52	62	66
10	8	11	15	19	24	29	35	43	50	58	66	75	81
12	9	12	17	22	28	34	41	50	59	68	78	88	97
14	10	14	19	25	32	39	47	57	68	78	90	101	112
16	11	15	21	28	36	44	53	64	76	87	100	114	127
18	12	17	24	31	40	49	59	71	84	96	110	126	142
20	13	19	26	33	43	53	64	77	92	105	120	138	155
25	16	22	31	40	52	64	78	93	110	128	146	168	190
30	18	25	36	47	60	75	91	109	128	149	172	198	225
35	20	28	41	53	68	86	104	124	146	170	196	228	260
40	22	31	45	59	76	97	117	139	164	190	221	257	295
45	24	34	49	65	84	107	130	154	182	210	245	286	330
50	26	37	53	71	92	117	142	168	200	230	267	315	365
60	29	43	62	82	108	136	165	197	234	270	314	366	435
70	32	49	70	93	123	155	188	226	268	310	360	425	505
80	36	54	78	104	137	173	211	255	301	350	406	478	570
90	40	59	85	114	151	193	233	281	334	389	448	530	635
100	43	64	92	124	165	210	255	307	365	426	490	590	700
120	49	74	107	144	192	246	300	359	427	500	574	690	825
140	55	84	121	164	218	281	345	410	487	570	658	790	950
160	61	94	134	183	243	315	390	460	547	640	740	890	1070
180	67	103	147	202	268	349	430	510	607	710	820	990	1190
200	73	111	160	220	292	383	470	560	667	780	900	1080	1310
220	78	119	173	237	316	416	510	610	724	845	980	1170	1420
240	83	127	186	254	340	449	550	660	781	910	1060	1260	1530
260	88	135	199	271	363	481	590	704	838	970	1134	1350	1640
280	93	143	211	288	386	513	630	748	894	1030	1207	1440	1750
300	98	151	223	305	409	545	670	792	950	1090	1280	1530	1860
320	103	159	235	322	432	576	705	836	1000	1150	1350	1620	1970
340	108	167	247	339	455	604	740	880	1050	1210	1420	1710	2080
360	113	174	259	356	478	633	775	924	1100	1270	1490	1800	2190
380	118	182	270	373	501	662	810	967	1150	1330	1560	1890	2290
400	123	190	281	390	523	691	845	1010	1200	1390	1630	1980	2390
420	128	197	292	405	544	720	880	1048	1248	1448	1694	2064	2490
440	133	204	303	420	565	748	915	1086	1296	1506	1758	2148	2590
460	137	211	314	435	586	776	950	1124	1344	1564	1822	2232	2690
480	141	218	325	450	607	803	985	1162	1392	1622	1886	2316	2790
500	145	225	335	465	628	830	1020	1200	1440	1680	1950	2400	2885
520	149	232	345	480	648	856	1050	1238	1486	1734	2010	2476	2980
540	153	239	355	495	668	882	1080	1276	1532	1788	2070	2552	3075
560	157	245	365	510	688	908	1120	1314	1578	1842	2130	2628	3170
580	161	250	375	525	708	934	1140	1352	1624	1896	2190	2704	3265
600	165	255	385	540	728	960	1170	1390	1670	1950	2250	2780	3360

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ESC Field Activities

WORKING WITH SLOPES, PROFILES AND CONTOURS

General

At times, outdoor activities will include some consideration relative to the physical character of the area under study. Determination of the slope or contour enables one to correlate the topology of the site to distribution patterns of plants and animals, moisture relations, soil types, or aid in the interpretation of land use practices. A modification of the contour methods is used in the development of stream profiles. Each of these activities is discussed briefly in the pages that follow.

Measuring Slope Per Cent

1. Select a representative slope without an extreme break in profile.
2. Have your team assistant set up a rod at a point 50 ft uphill from your level and take a reading.
3. Then the rodman moves directly downhill 100 ft and takes another reading.
4. The difference in these readings is the per cent of slope or fall in feet per 100 ft at that point. (Example: Figure 1. 6 ft minus 2 ft equals 4 ft fall/100 ft or 4% fall/100 ft)

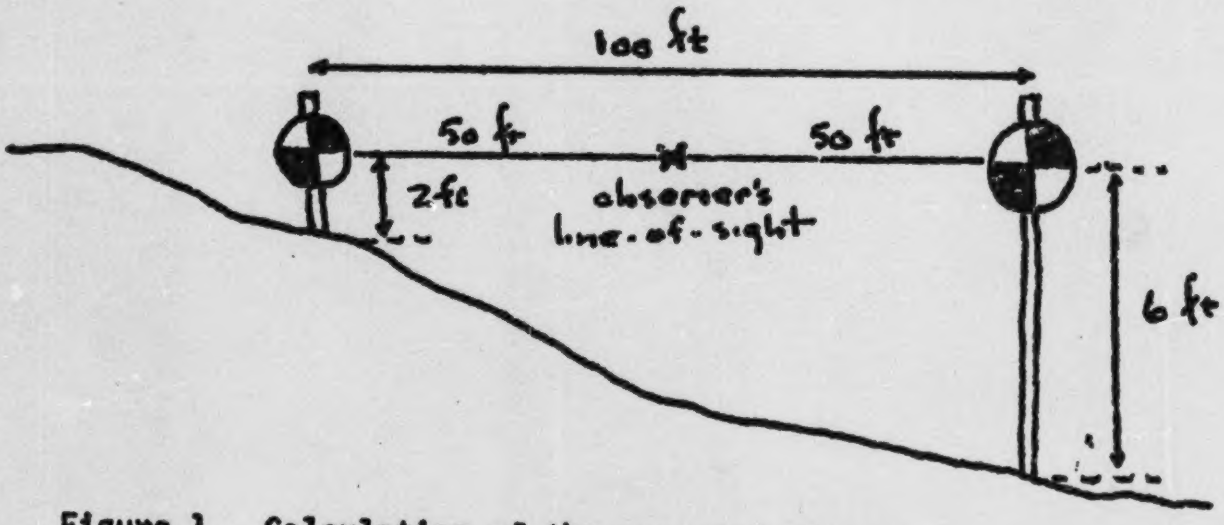

Figure 1. Calculation of the per cent slope.

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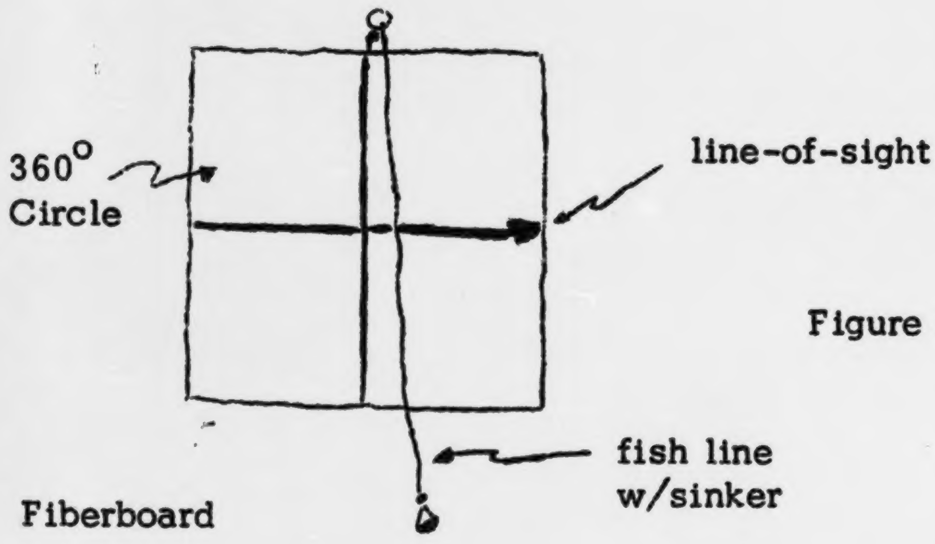

360° Circle
line-of-sight
fish line w/sinker
Fiberboard

Figure 2. Improvised transit apparatus.

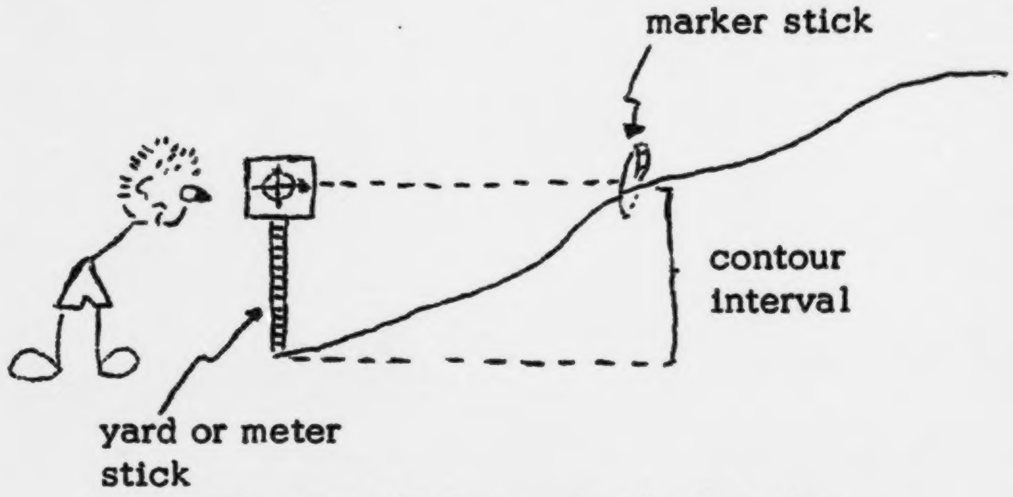
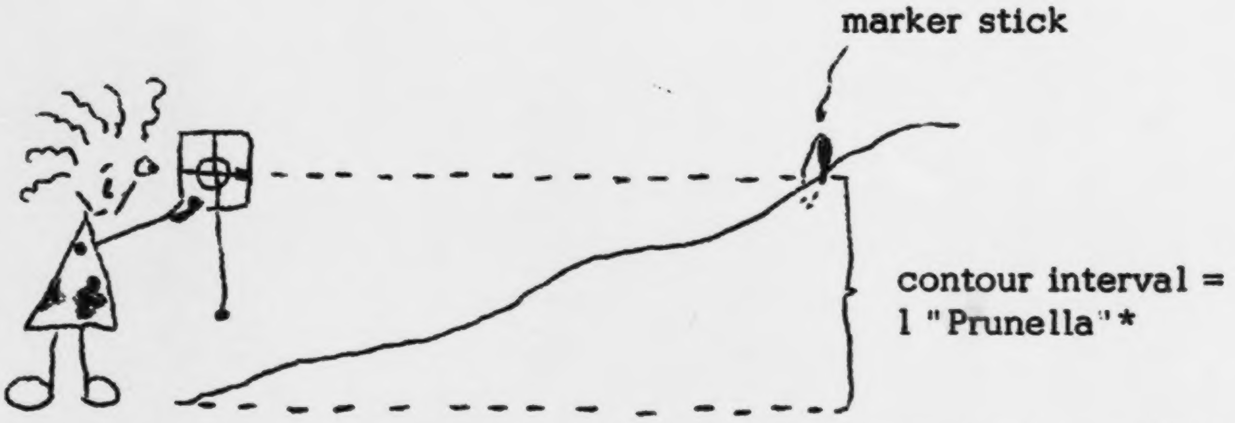

marker stick
contour interval
yard or meter stick

Figure 3. Using a standard contour interval.


marker stick
contour interval = 1 "Prunella"*

*Advantage - personal to student

Figure 4. Using an arbitrary contour interval.

Contour Intervals

Mapping the contour intervals on a study site may be accomplished by using the improvised equipment and methods shown in figures 2-6. It is advised that the field survey work be done in teams of two or more.

1. Before beginning a contour activity, one must select an arbitrary starting point and establish a base line. All other points in the mapping exercise are relative to this line. Briefly, one sights through the apparatus illustrated in figure 5. An assistant moves 15 to 20 paces along the slope. When the cross hairs exactly intersect the center of the device on the range pole (figure 6), the spot is staked. This procedure is repeated until you have a base line long enough to satisfy your needs.

2. If using a standardized contour interval (figure 3), place the transit apparatus (figure 2) on top of the standard and hold in position so that the plumb lin e is parallel with the vertical dividing marker.

3. Sight along the line-of sight arrow and have your assistant mark the spot with a stake or tongue depressor. You have now determined an increase in altitude equivalent to your standard interval. If the entire hillside is to be contoured, move up to that mark and repeat the above procedure until you have reached the top.

4. An arbitrary standard equivalent to the distance from eye level of the observer to the ground is an alternative method (figure 4). This kind of activity is fun for the students and the intervals appear as "pupil units."

5. For graphing purposes, a notation of the distance between the respective horizontal markers will become the "x" axis; the "y" is constant and equivalent to your standard.

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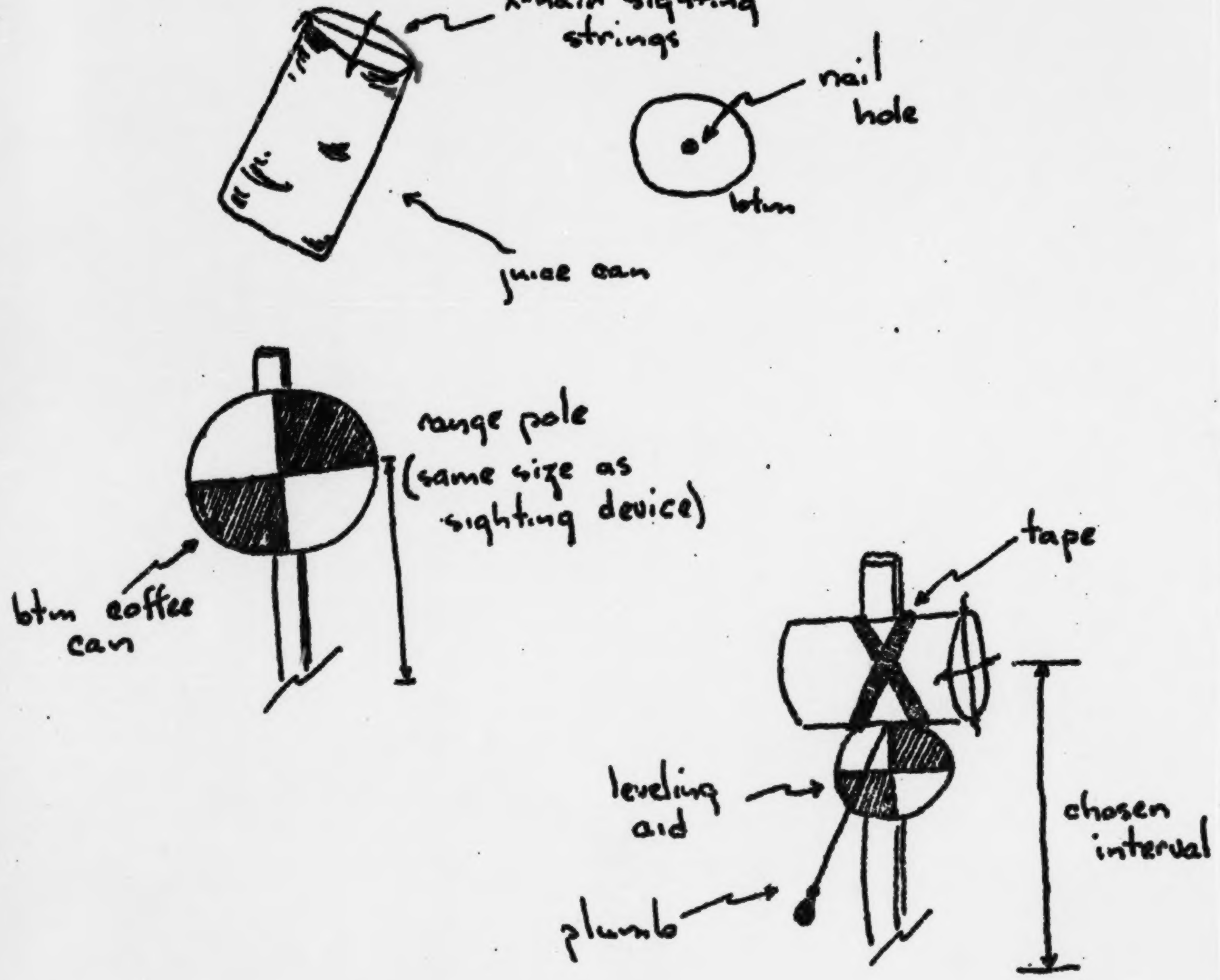
X-hair sighting strings
nail hole
btm
juice can
range pole (same size as sighting device)
btm coffee can
tape
leveling aid
chosen interval
plumb

Figure 5. Construction of sighting device and range pole. The sighting device can be used as an alternative for the improvised transit apparatus (fig. 2).

Stream Profiles

The construction of a stream profile can be accomplished with the improvised equipment illustrated in the preceding pages. To determine the profile work in teams of at least two.

1. Select a sighting device which complies with your desired interval. The apparatus illustrated in figures 3 and 5 is adequate for this purpose.
2. Have your partner mark the spot where the line-of-sight intersects the bank upstream (figure 3).
3. Measure the distance from your location to that of your teammate.
4. The measurement recorded is the distance the stream travels before it decends an amount equivalent to your interval.
5. Move upstream to your helper and have him mark the next intersection point upstream. Repeat the above until the desired length for the stream profile has been recorded. The distance between the marks becomes the "x" axis and the "y" is equivalent to your interval marker.

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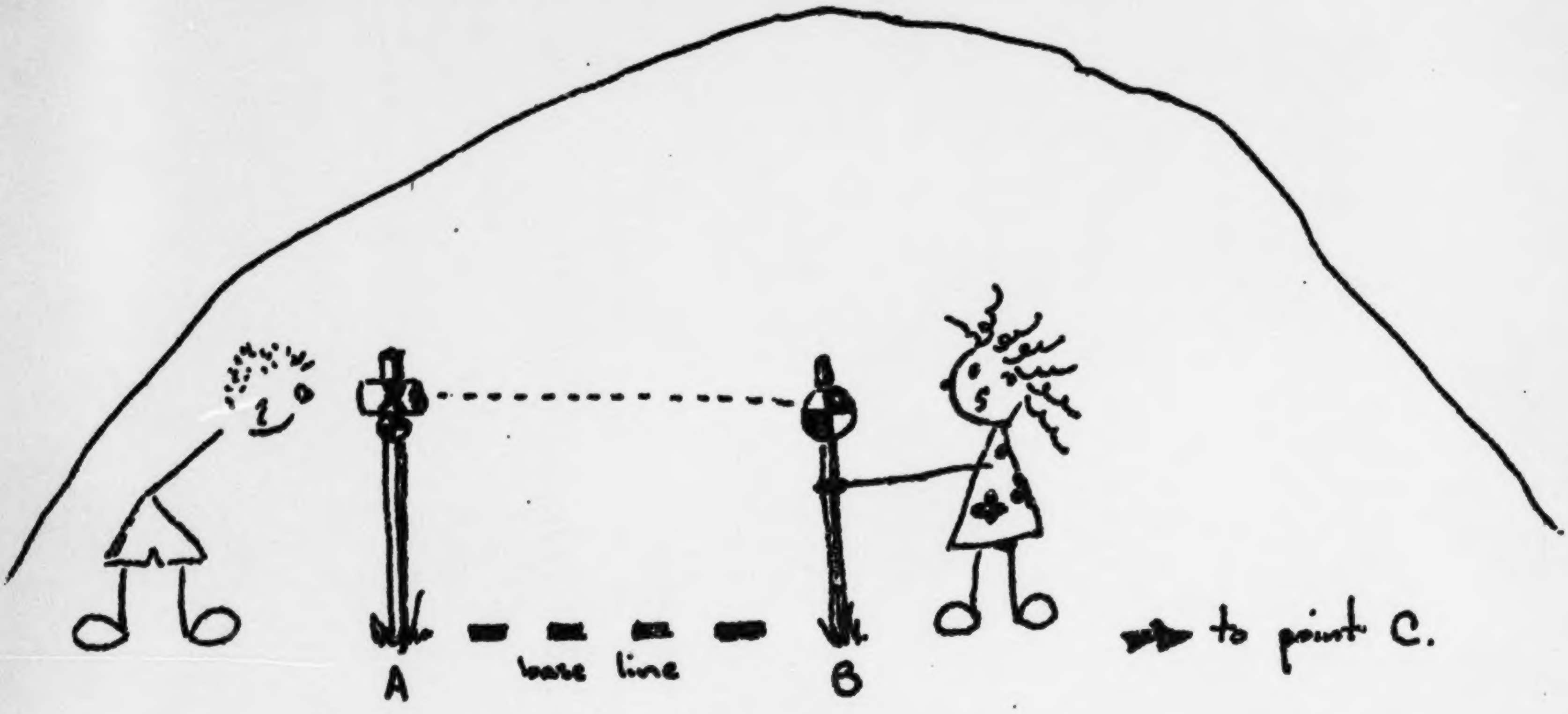

Figure 6. Using the sighting device and range pole to establish the base line. Points are staked and the procedure repeated for each of the contours until the top is reached.

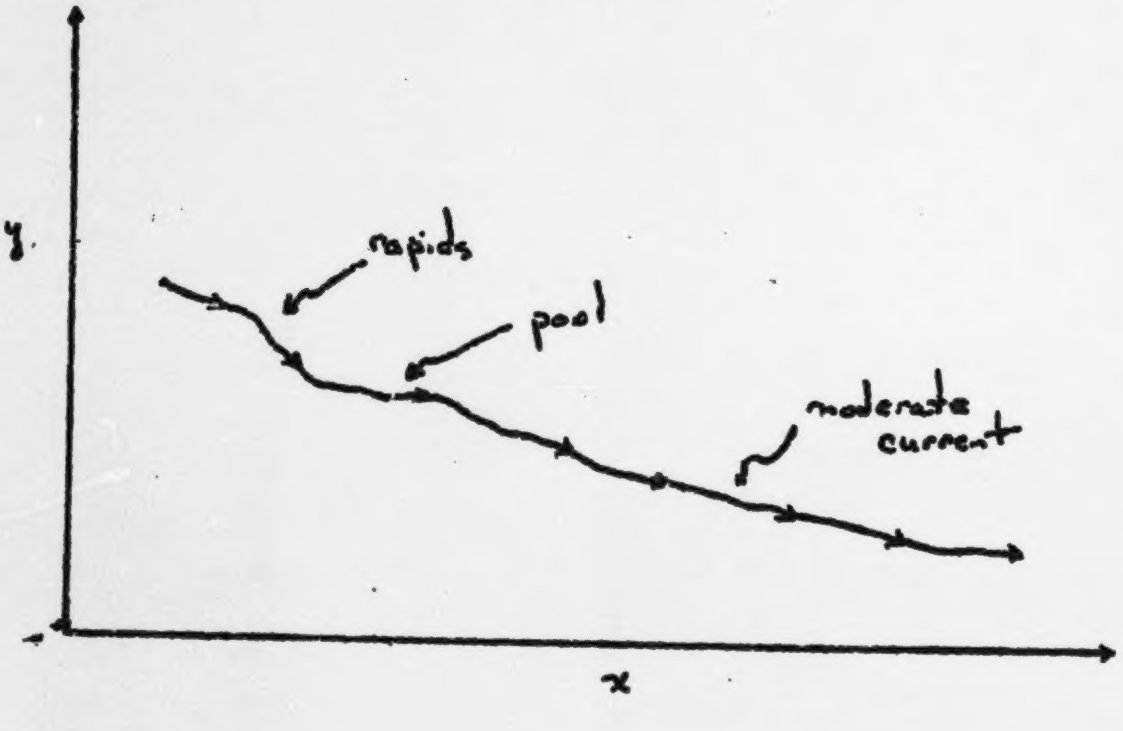

Figure 7. An example of a stream profile. After the above physical characterization, correlations can be made relative to the dissolved gases, minerals, or distribution of life forms.

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STREAM PROFILES

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BACKGROUND

Freshwater communities may be arbitrarily divided into two types: (1) standing water, such as ponds, lakes and swamps and (2) running water, including rivers and creeks. The degree of water movement in aquatic communities has much to do with the kind of orgamisms found in them. However, it would be misleading to state categorically that stream organisms do not live in pond habitats and pond organisms do not inhabit streams. Many streams are characterized by associated pools where water moves sluggishly at an insignificant velocity or not at all. It may be possible to find organisms ordinarily typical of ponds in such pools. Thus, the range of aquatic habitat types found in many stream communities in part explains the variety of organisms which can be collected there.

The stream community is an exciting one to explore. Most streams contain a large number of species whose adaptations to life in swiftly flowing water intrigue both adults and children alike. A brief investigation of stream water ordinarily yields enough biological material for weeks of study. And, in addition to biological relationships, other factors affecting the distribution and types of organisms found may be investigated in a stream. Its topology, velocity, bottom composition and the temperature gradient along its length are all significant determinants of organism type and should be studied as part of stream ecology.

In order to begin to understand the ecology of a stream, students should be given the opportunity to do field work at a stream site. Such sites are not always to be found within walking distance of most schools. Should this be the case, a field trip to a nearby forest preserve or other area should be considered. Often it is possible to obtain permission to utilize private property for study areas also. The State Department of Conservation and other conservation agencies may be able to locate a field trip site for you.

This lesson will introduce you and, in turn, your students to several activities and investigations appropriate for beginning stream study. The equipment needed is easily constructed and inexpensive in cost. The data derived from the activities will be plotted on a class profile map which subsequently will provide background information for discussion and further investigation. Several ideas for follow-up studies are suggested at the end of the lesson.

MATERIALS

Item	Description	Source	Quantity
Level	Masoner's	Hardware Store	1
Poles	Clear Pine, 1 x 1 x 10	Lumber Yard, Home	2
Screening	Standard Mesh in 2 ft. x 2 ft. pieces	Hardware Store, Lumber Yard	1/group of 3 students
Doweling	3/4 in., 36 in. lgths.	Hardware Store, Lumber Yard	2/group of 3 students
Staples, Tacks		Hardware Store	Several boxes
"Mystic" Tape, red		Hardware Store	2 rolls
Plastic Bags	Baggies	Grocery Store	2 rolls
Butcher Paper	14 ft. length	School	1 sheet
Graph Paper	1/4 in. squares	School	2 sheets/group
Tape	Measuring	Home, School	1
Thermometers	Metal-backed alcohol variety	School, Supply House	1/group

INTRODUCTION

The purpose of this lesson is to describe ways to involve children in a significant investigation of one aspect of the environment. Similar kinds of environmental investigations can be conducted on prairies, school or home lawns, in forests and at pond sites. The common element in all these kinds of studies is the systematic collection of data along a predetermined line. In this lesson the line is the creek itself; in other studies the line is determined arbitrarily but is usually laid out through transitional regions or regions of interest to the investigators. Systematic observations are made at fixed intervals along the line in order that sufficient data is collected over a large area. The same type of observations are made at each interval.

In this lesson the children will work in groups of three. Each group will study ten feet of a stream. The observations each group will make involve temperature determinations, organism and stream bottom sampling. The data derived from these investigations will be plotted on a large profile map of the stream. The profile is constructed by surveying for changes in stream elevation. Elevation changes will be plotted for the length of the stream studied. Finally, the students will attempt to draw correlations between elevation and temperature, composition of stream bottom, and organism types.

As a result of these activities it is hoped that children will begin to understand that a stream has pattern to it. That pattern will be consistent over the length of the stream as long as other factors do not change — in particular, the velocity of the water If the students are able to grasp the idea that pattern is arrangement and orderliness, they should be able to understand that similarity among natural communities is a result of the similarity among interacting variables. Simply stated, things are where they are because conditions favor their existence. It is possible then to find the same organisms living in widely distributed habitats only because each habitat is characterized by the same elements or components. Thus, if one collects organisms from streams draining into a river, most of these streams, though miles apart, will contain the same organisms. Knowledge of patterns, then, contributes to one's ability to predict certain events. This is the essence of science perception of order — patterns · enabling one to generalize to similar situations.

These ideas cannot be understood through exposure to a single science lesson. Understanding is built through multiple exposure and involvement. Each experience prepares the student for the next, broadening and deepening his understanding of his environment with every step taken. Your role will be to guide and support student interest and enthusiasm as they experience their environment through direct involvement.

PROCEDURE

Part 1. Building the Equipment

Gather together the material needed sometime before the field trip is to be taken. Often children are able to find these things at home obviating the necessity to buy them. Inquire as to their availability in homes and then determine how much should be purchased. Set a deadline for bringing materials to class. When everything is assembled, construction can begin.

Following are pictures of equipment with instructions for assembly. Several periods may be required to finish construction. Plan to spend at least a half a day in the field.

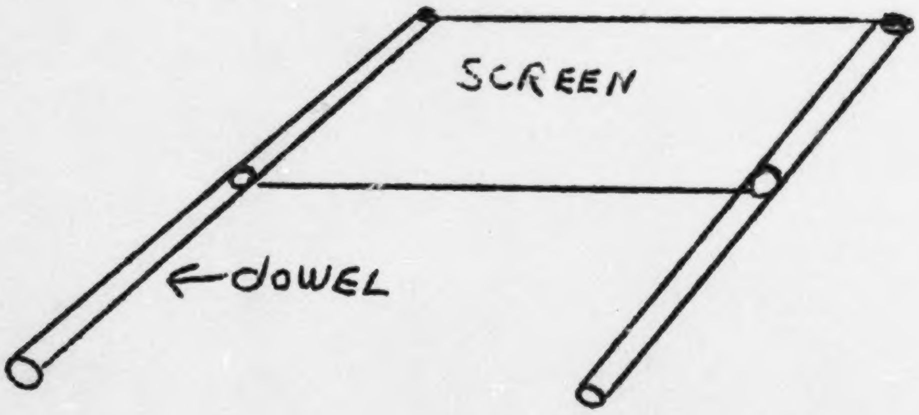
SCREEN
← DOWEL

Figure 1. Stream Sampling Screen

The wire screening is merely wrapped around the dowels and tacked or stapled in place. Make certain a sufficient number of staples or tacks are used to secure the screens to the dowels, as they will receive some abuse when used for collecting purposes.

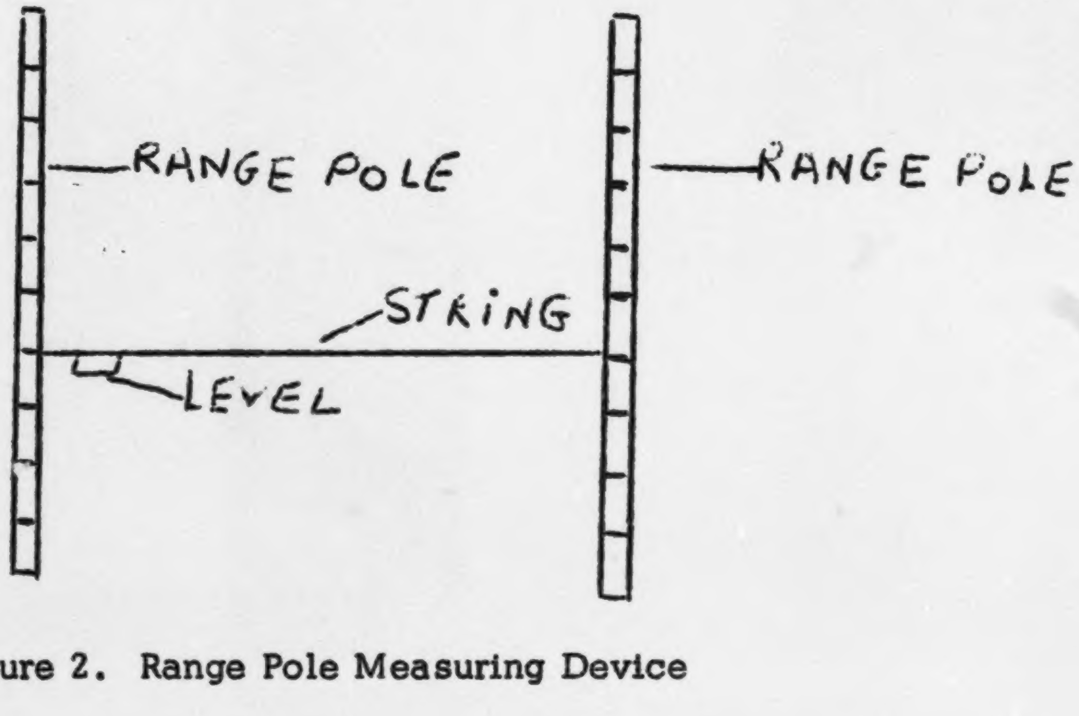
RANGE POLE
RANGE POLE
STRING
LEVEL

Figure 2. Range Pole Measuring Device

This piece of equipment is used to measure elevation along the length of the stream studied. It consists of two poles — range poles — made of the clear pine 10 foot lengths, a piece of string and the masoner's level. Each range pole has been marked off into one foot intervals. "Mystic" tape may be used to mark the intervals. A length of string, perhaps 10 feet, is strung between the two poles and a level is attached. Levels of the type recommended have hooks on them for purposes of attachment. The string must not be tied too tightly around each pole, as it will be slid up and down the pole during its use.* While the lesson recommends the construction of only one range pole device, the children may make as many for the class as time and resources permit.

Steel measuring tape may be used to mark off sections of the stream for study by individual groups. In place of steel tape, rope cut to desired lengths may be marked off in one, two, or three foot intervals to be used to measure study sections.

Part 2. Pre-field Trip

The class should be made aware of the purpose of the field trip — the study of a stream, its biology and physical features. Several class periods can be spent building the equipment and practicing its use. It is particularly important that the class understand how the double range pole device is to be used before trying it in the field. Provide sufficient time for practice with it.

The screen sampler has been designed to use as a means of collecting floating organisms or as a surface for sorting out debris taken from the bottom of the stream. Floating organisms are collected by holding the screen by its handles and holding it on to the bottom at a slight angle so that nothing slips under it. If debris is collected — rocks, water plants, leaves, etc. — it may be placed on the screen on the ground for examination. The screen prevents most larger organisms from escaping to the ground.

The class should be cautioned to wear appropriate field clothing — old clothes, boots, etc. You will also want to discuss field trip behavior with them. To facilitate organization, teams of three can be identified prior to the trip. Each team would be responsible for transporting its own equipment. It is recommended that students read about aquatic environments after the trip. Written material will have more meaning for them after they have had the experience of first hand observation.

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*Actually one side can always be fixed at a convenient level for reading; the other is moveable. Why this is so will become clear when the equipment is put to use.

Part 3. Double Range Pole Use

The double range pole will be used to measure the changes in stream elevation. The measurements will result in a profile of the stream. The profile will be used as the basis for organizing other data collected.

Once the double range poles are marked off in one foot intervals, attach the string to each pole. Take the class outside and select two students to hold each pole upright on the sidewalk. Slip the string down to the bottom of each pole and attach the level to it. The distance between poles should be adjusted so that the string is stretched tautly before the level is attached. If the sidewalk is level, the bubble in the level will orient itself between the two marks on the glass tube. Make certain all the students observe this and know how to ascertain levelness.

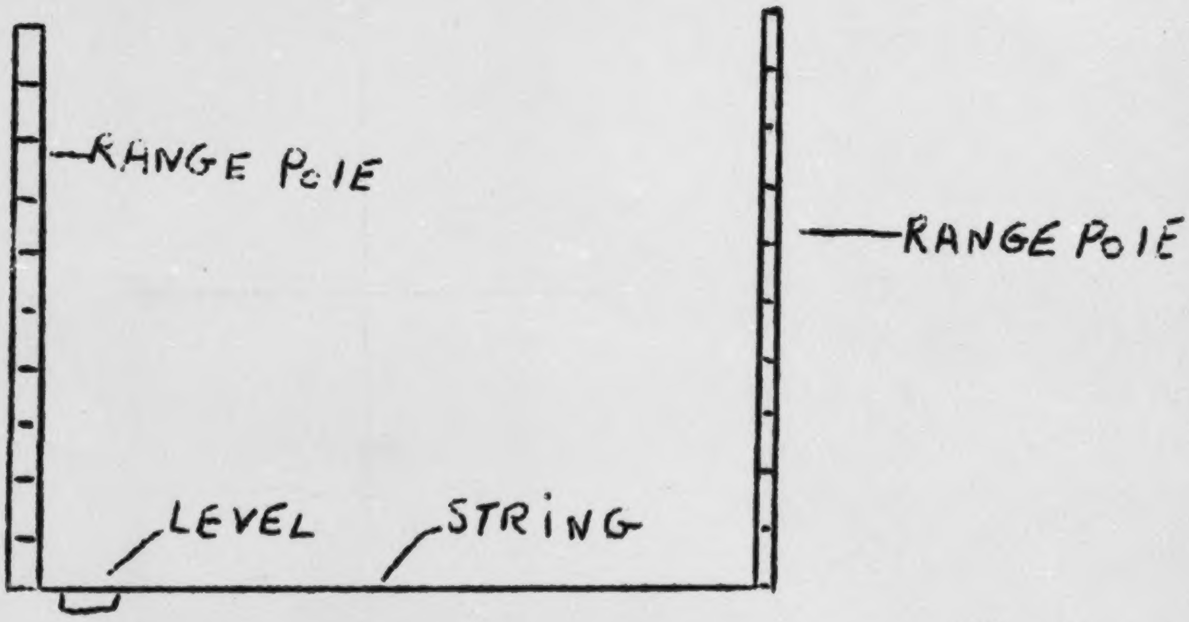

Figure 3. Using the Double Range Pole

When you are certain students understand that the centered bubble indicates the walk is level, move the range pole team to a set of stairs, curb, hill or other elevated place. Have one student place a pole on the elevation while the other places his on the ground. (See Figure 4.)

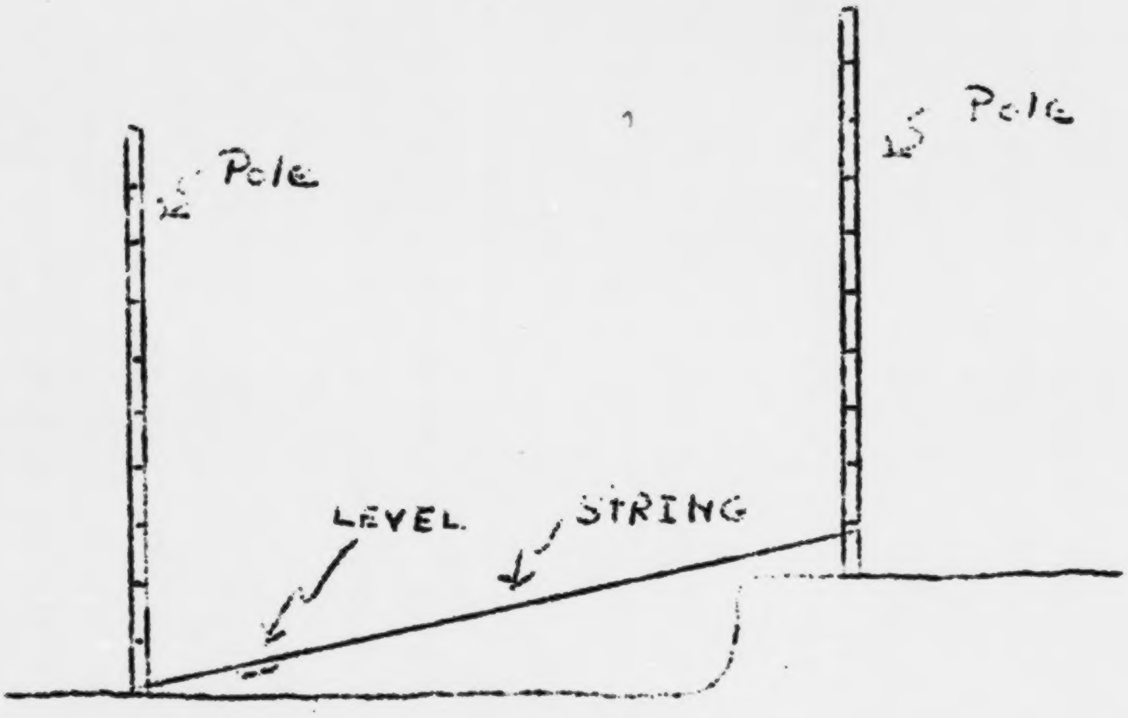

Figure 4. Unleveled String

The string will have to be slid up the elevated pole. Place the level on the string after it is stretched. Does it read level? Without moving the poles, how can it be made to read level? The students will probably suggest moving the string which is what should be done. (See Figure 5.)

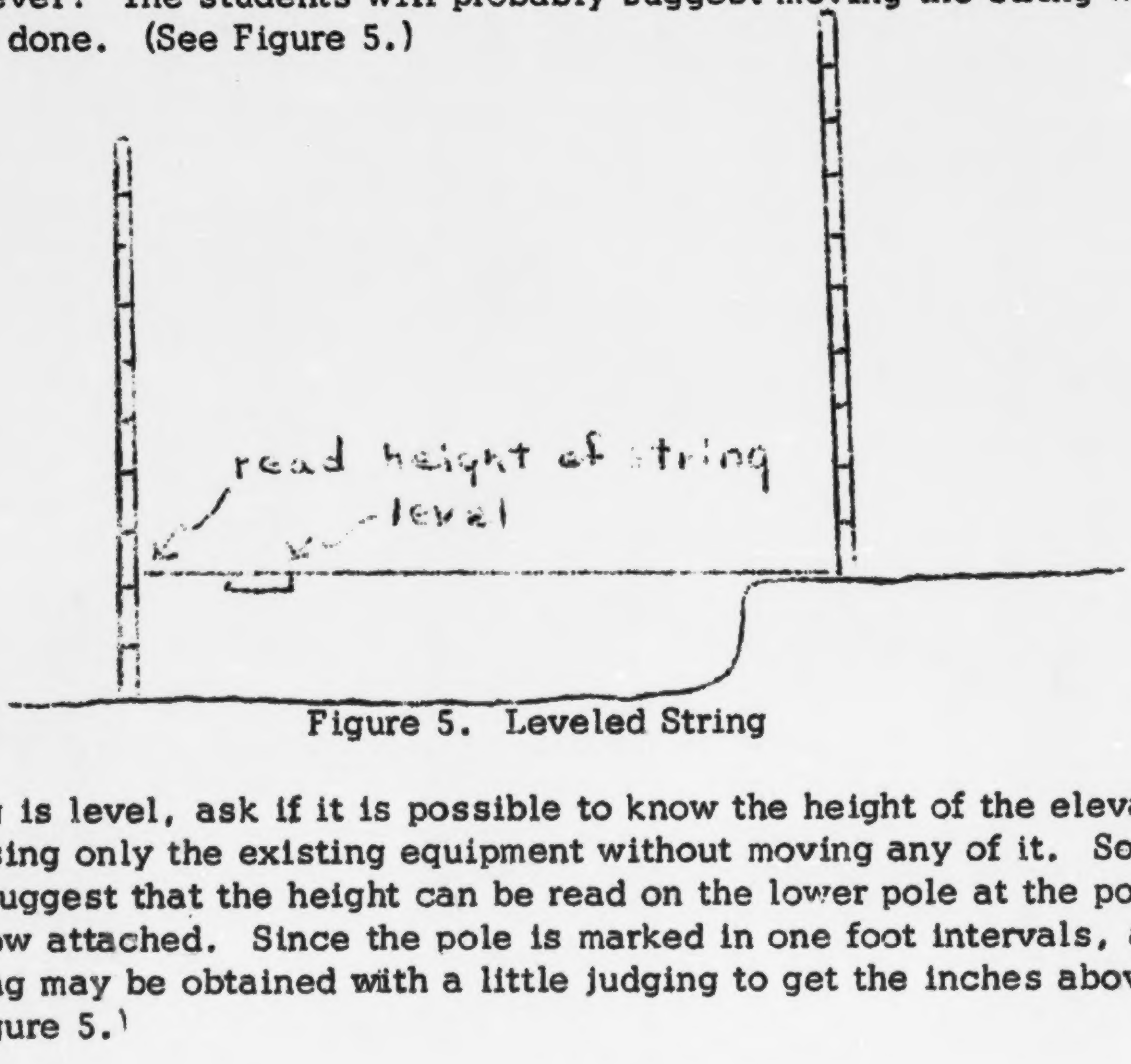

Figure 5. Leveled String

Once the string is level, ask if it is possible to know the height of the elevation of the one pole using only the existing equipment without moving any of it. Someone will no doubt suggest that the height can be read on the lower pole at the point where the string is now attached. Since the pole is marked in one foot intervals, a fairly accurate reading may be obtained with a little judging to get the inches above a foot mark. (See Figure 5.)

Several trials will be needed for students to accustom themselves to the use of the double range pole. Provide sufficient time for practice until all can use it with accuracy.

Part 4. Field Trip

When the stream site is reached, distribute the teams along successive ten foot sections. Assign each a number or letter designation according to their position in the sequence of groups. Ten foot sections should be determined by measuring the footage with the steel tape or rope. Give each group a large piece of paper (clipboards or notebooks could be used to write on) and instruct them to make an inspection of the bottom of their section of the stream. (If the stream is not clear, this cannot be done, of course.) They should note patterns formed by the distribution of materials along the bottom. Some portions may contain large pebbles, other sand, or silt. Portions can be differentiated by color and particle size. When they are familiar with the pattern, ask them to reporduce it on a drawing similar to the following:

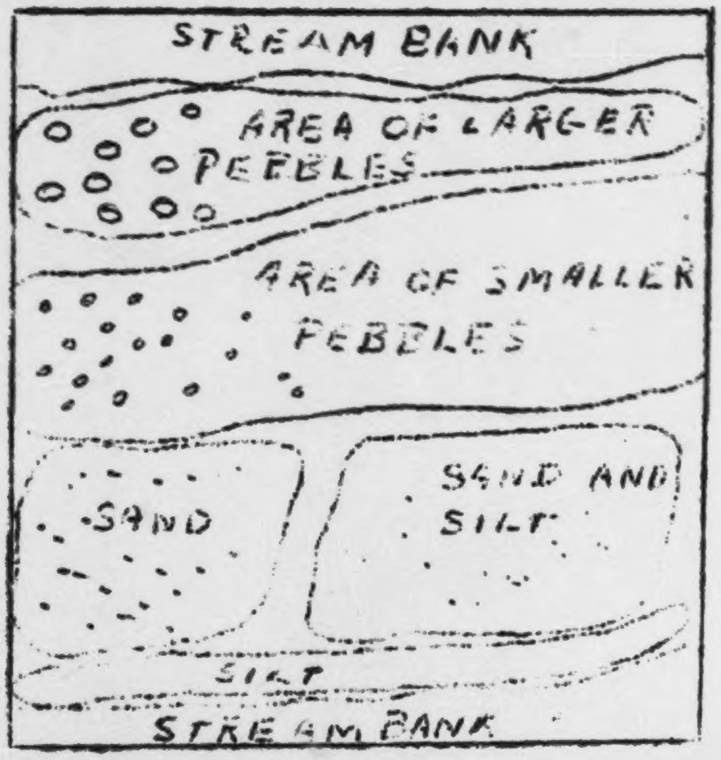

Figure 6. Sample Stream Bottom Pattern

Each group should make and record the following observations for each part of the pattern:

1. Temperature. Temperature should be taken and recorded on the sketch--several according to the pattern. Difference may exist if there are significant differences in the stream bottom. Have them also record the temperature of the air.

2. Samples of the Stream Bottom should be collected for each different bottom section. These may be kept in separate plastic bags.

3. Organisms. Place the screen on the stream bottom, again referring to the pattern sketch for placement. Gently agitate the bottom to dislodge organisms living there. Remove the screen and place it on the bank. Sift through the material and collect the organisms in plastic bag. Do this for each different area on the stream bottom. Identify the bags properly. Gather leaves and sticks from the different stream areas and place them on the screen for examination. Any animals found adhering to these objects should also be collected in the appropriate plastic bags. Make certain students make a thorough search of the debris.

4. Elevation. Use the double range pole to obtain elevation changes for each stream section. The same technique used at school will apply here, although changes may be slight and therefore somewhat difficult to measure. Each group should record the total elevation change from the beginning of their section to its end. Elevation should be found in the stream if possible.

5. Plant Material. Plants characteristic of the stream bottom or immediately adjacent banks should also be collected in plastic bags.

Students should spend some time familiarizing themselves with the general area, land features, and larger vegetation types growing near the stream. Many of them will enjoy walking up or down stream, watching others and comparing finds. Encourage them to share observations with one another. Check each group from time to time to make certain their observations are being recorded. If the stream is deep, or particularly fast flowing, you will want to caution them to avoid placing themselves in a position which might lead to trouble.

When each group has made and recorded its observations, it would be worthwhile to sit down together to discuss their work and discoveries. You might pose some of the following questions for their consideration.

1. Were there any temperature differences between swift and slow moving portions of the stream? How could they account for this?

2. Where were most organisms found--in the debris or free swimming? How could they explain their answer?

3. What are some means animals have for preventing themselves from being carried down stream with the current?

4. What other observations can be made about the stream in addition to those already made?

5. If they surveyed another stream several miles away, what might determine whether or not similar organisms and conditions could be found there?

Many students will want to know the names of the various animals found. Suggest they make up some names and assign them to the organisms. The rule here is to be certain one animal is not designated by two different names. Interested students can be directed to source books to find the common names for the animals.

The observations made by the students are by no means the only ones which can be made. Perhaps some were suggested in discussion. Time limits and level of sophistication of your students should guide the selection of additional investigations. Of particular importance in the study of streams is the velocity and oxygen content of the water. Both factors influence the type and distribution of animals; further investigation should include activities designed to test them.

Part 5. Recording Observations.

If an enclosed shelter with picnic or other kinds of tables is not available on the study site, the data should be taken back to the classroom for compilation. It is difficult to graph and record in the field, especially if it is windy. Specimens can be returned easily in plastic bags if they are in a small amount of water. Tops can be sealed by knotting the plastic or placing rubber bands around them. They should be examined immediately the next day, as they will not live long in still water.

On the next day, lay out the butcher paper on a large flat table or on the floor. Provide each group with one or two sheets of graph paper to tape to the butcher paper. Each sheet should be placed by groups in order of their position along the stream. Thus, group A should be first, B next and so on. Arrange this order so that the lowest stream elevation is at the left hand portion of each graph. As the profile develops, it will rise from left to right.

Assign the group whose section was at the lowest point in elevation the task of constructing an elevation scale on the left hand margin of their graph. To do this, you must first find out through discussion what the total elevation change was. Beginning with the first group, have them report the change in their section; add to that figure the change found by the next group and so on until all groups have reported Once you have a cumulative total, you will know what the upper limits of your elevation scale should be. Thus, if over a 100 foot linear distance, the creek is found to rise 10 feet from lowest to highest point, the elevation scale would be 0 to 10 feet. Expand the scale sufficiently so that a large graph will result.

Now ask the first group to place the scale on their graph at the left hand margin. The horizontal scale on the graph will represent linear feet. That scale will total the numbers of feet of stream worked by the class. If there were 10 groups, each working a ten foot section, the horizontal scale will range from 0 - 100 feet. Let the bottom margin of each sheet of graph paper represent a 10 foot section of the creek. Each group then will plot elevation on the graph paper designated by their group number or letter. When this is done the graph will look something like the following:

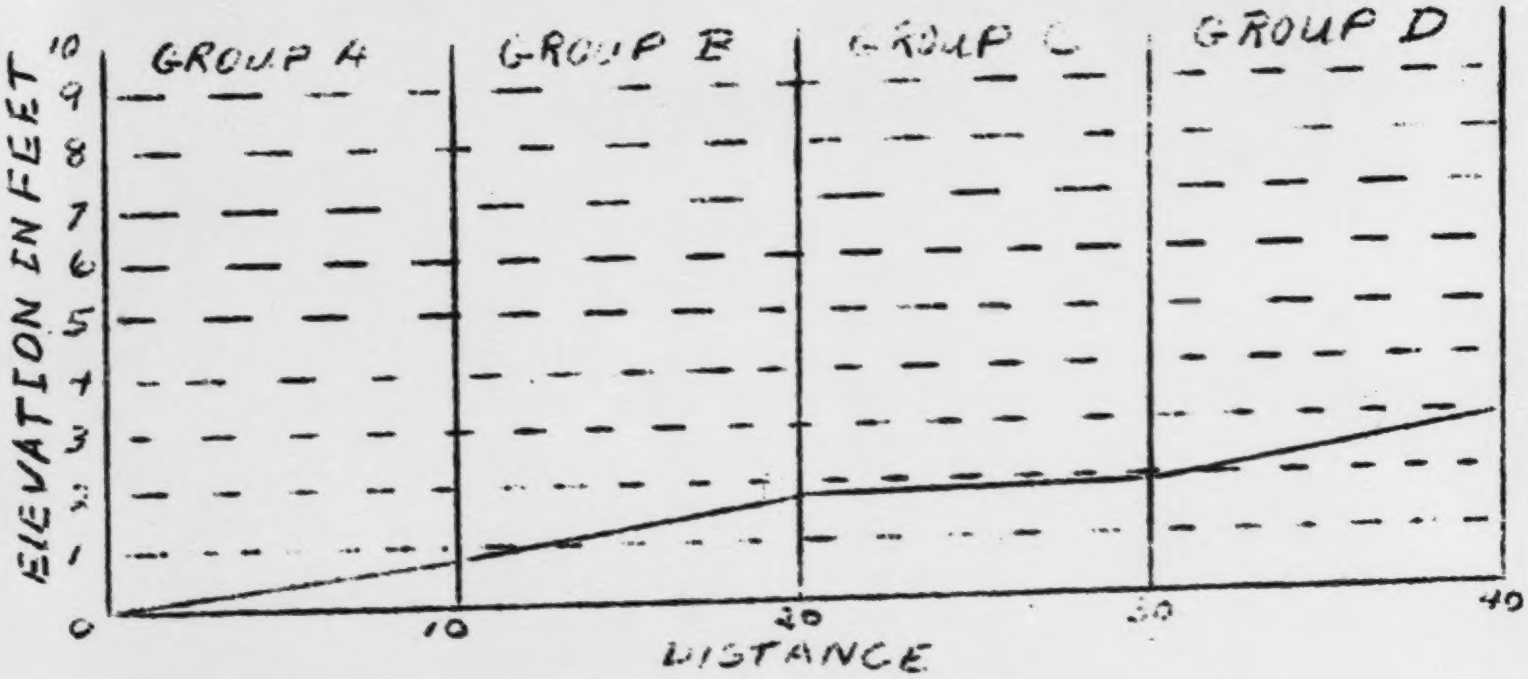

Figure 7. Graph of Stream Profile

When the graph is set up as shown, each group may begin to plot their stream elevation data. The result will be a profile of the drop in elevation (or rise) over the distance measured. (See Figure 6.) Note that each group begins to plot their elevation data at the point where the preceding group finished their plot. Thus, group "B" found the rise along their section to be about one foot while the elevation at the end of their section was almost two feet above the beginning point, O.

Once the profile has been constructed, other data can be plotted on it. They should obtain their drawings of the stream bottom pattern and afix them to the chart above the profile. Water temperatures were recorded for each area on the sketch, but air temperature was not. It should be recorded immediately above the profile line. The plastic bags containing bottom samples and organisms should be placed on the appropriate area of the pattern. (If some of the drawings are very small, have the groups enlarge them so that all the drawings are approximately the same size. It would also be helpful if the symbols used to represent different bottom materials are uniform. Thus "large" pebbles should be drawn about equal in size on each sketch.)

If the children would like, they may dry out their stream bottom samples for direct placement on the graph. Glue may be used to cause the material to adhere to the graph. Have them refer to their recorded descriptions to aid in the placement of the material. The completed graph might look like the following:

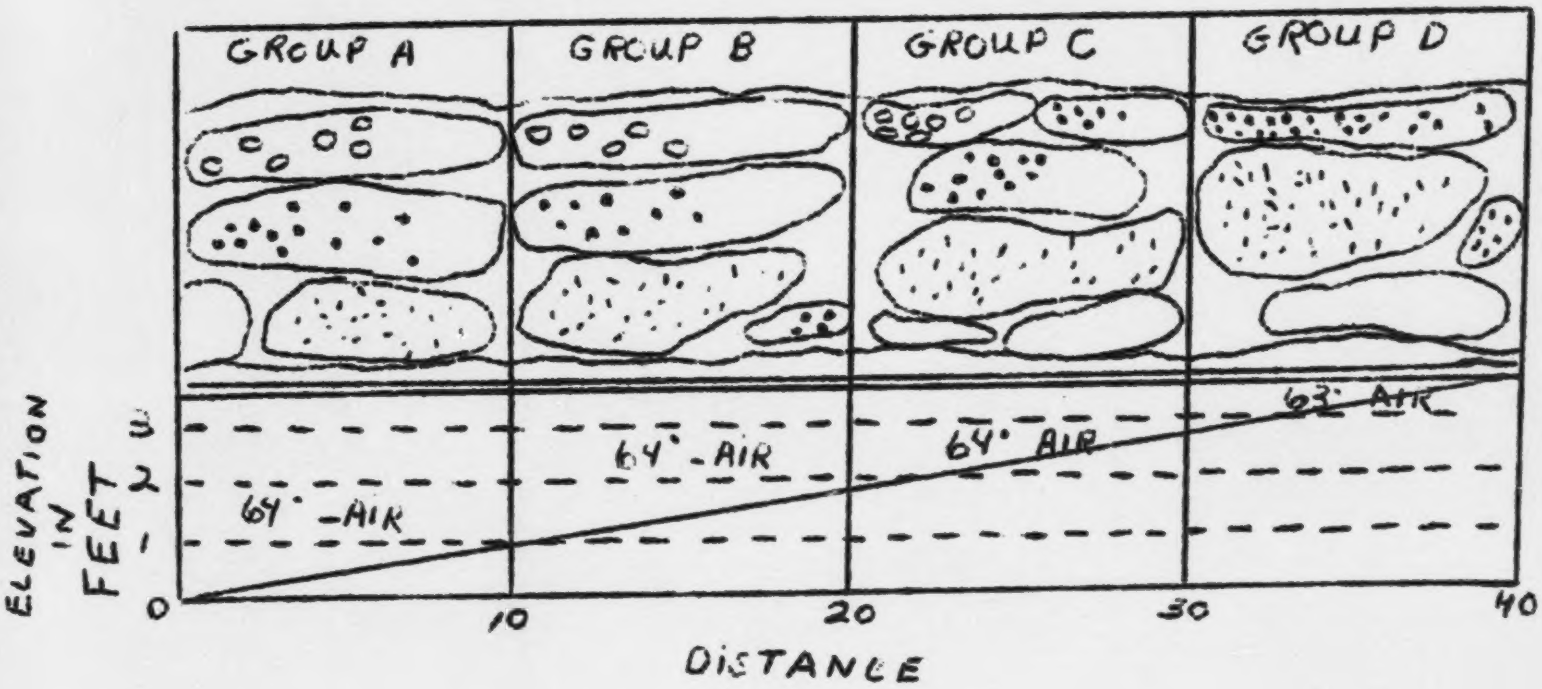

Figure 8. Completed Chart

Part 6. Discussion

Once all the data is placed on the composite graph, the children should be given time to observe one another's data and collection of organisms. Have them compare their findings with one another. Encourage them to choose names for their organisms so that they are able to communicate with one another about what they found. See if they are able to find any relationships between the following:

(1) Elevation and temperature.

(2) Organism type and bottom composition.

(3) Air temperature and water temperature.

(4) Water temperature and bottom composition.

(5) Elevation and organisms.

Additional questions to ask during the discussion might include:

(1) Did everyone seem to find about the same organisms? Were they distributed rather evenly in numbers along the stream length or did they occur in a pattern? Is that pattern related to stream bottom pattern?

(2) If the stream began to dry up, with a consequent decrease in water velocity, would this affect the kinds of organisms found?

(3) If samples were collected in fairly quiet pools along the stream, were the types of organisms inhabiting these pools different from those found in the main part of the stream?

(4) What might be sources of food for the animals? Will they all eat the same thing?

(5) Will the stream contain about the same kinds of animals all year long? (If possible, perhaps a fall or winter field trip could be taken to find an answer to this question.)

(6) Could they predict the relative velocity of the stream by examining the patterns formed on the stream bottom? How does particle size relate to velocity?

(7) What could cause a change in the stream bottom pattern?

Part 7. Additional Activities

(1) Children may examine the organisms in more detail, identifying some of their possible adaptations to a swift stream habitat.

(2) More field trips could be taken to find out if changes in seasons affect the stream.

(3) Additional data can be collected on stream velocity. Velocity is easily, if somewhat inaccurately, computed by timing the movement of an object thrown into the stream over a measured distance. Cotton, twigs, etc. could be used here.

(4) The oxygen content of the stream can be checked. The standard method is rather complicated however, unless pre-prepared chemicals are used.*

(5) A running water aquarium might be constructed in order to maintain the organisms for further study. Additional collection trips must be made to obtain more animals.

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* Hach Chemical Company, P.O. Box 907, Ames, Iowa 50010

ED0 42638

TREE WATCHING

- Poem
- Introduction
- Initial Study of Tree
  - Drawing
  - Photograph
  - Maps
  - Branching
  - Damage
  - Animals and Insects
- Extended Studies
  - Drawings
  - Photographs
  - Leaf Study
  - Tip End of Branch Study
  - Plants Growing Under the Tree
  - Soil Study
- I Know a Tree — Game
- Watching a Dead Tree
- Watching a Rotting Log
- Mapping

SE 009 754

TREE WATCHING

An interesting tree
Especially for me
One to visit
To look at a lot
A tree to draw
To wonder about
I'll find my tree
That's so special to me.

Trees are naturally friendly companions to man. Most children enjoy making friends with a tree. In this lesson the children get to know their tree by examining it carefully, describing it in detail, studying the soil it grows in, and the plants that grow with it. The children study the leaves or leaf buds through the school year, they watch for signs of animals and insect activity, and check the tree for damage. By "knowing" one tree well, its surroundings, and companions, the children begin to gain awareness of interdependence in nature.

Selecting the Trees

A class of 25-30 children may select one tree, several trees, or one tree for each individual.

If you are in a city school it may be best that you and your class select just one very interesting tree from your school yard surroundings, from your neighborhood, or from a nearby park. Be sure you select a tree that the children can watch on their own and that the whole class can visit about once a month throughout the year.

If there is indecision about which local tree is "very interesting", then select more than one. Small groups in the class can make their selection. Be sure the trees are either near the school or near each other. If they are several blocks apart it will mean taking two class trips each month to see them.

If you are near a wooded area or large park, you may be able to have each child "adopt" his own tree to watch. Again, be sure the trees are clustered so that in one trip you will be able to see all the trees and you, as the teacher, will be able to keep track of the children.

Organization

The activities of this lesson are divided into two sections — I The Initial Study, and II, The Extended Studies.

The extended studies may be done every month or three times during the year, Fall, Winter, and Spring.

Recommended intervals for the extended studies follows:

Drawings — 9 or 10 times (one every month from September to June) or three times (one every season, Fall, Winter, Spring)

Leaf Study — 5 or 6 samples (September, October, November -- March (leaf bud), April, May)

Plants Under the Tree — 2 samples (Fall and Spring)

Soil Under the Tree — 1 study (Fall)

Many samples (surface)

(6" below surface)

(12" below surface)

(18" below surface)

Booklet Containing All Data Collected

Plan to prepare a booklet for each tree you study.

If the class selects one tree you may choose to have everyone help to prepare one super-size book or you may want several books prepared by committees. You may even choose to have each child prepare his own booklet even though only one tree is being studied. The decision here will depend on what would work out best for you and the children in the class.

If the class plans to study several trees, then each group will prepare a booklet of data for their tree.

If there are individuals in the room studying their own tree, then each will develop his own booklet.

I. Initial Study

  A. Select a tree or trees.

  B. First visit

    1. Draw tree.
    2. Photograph tree (if possible).
    3. Select a leaf sample.

C. Maps — Have children draw a map (suggested procedure is at the end of this unit).

D. Second visit

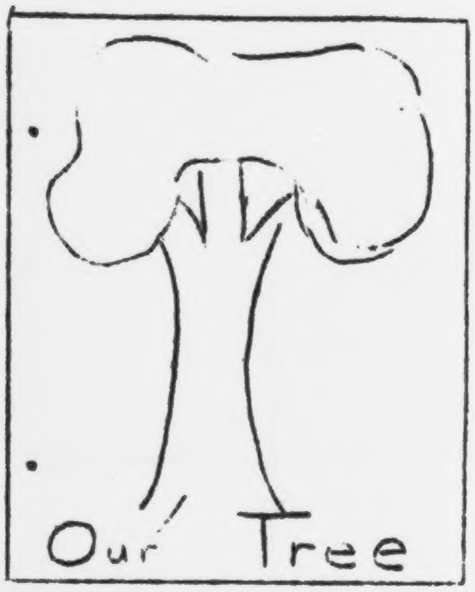
1. Observe and draw branching patterns. Use a small branch taken from the tree.
    - a. Opposite
    - b. Alternating
2. List any visible damage to the tree and draw.
    - a. Holes
    - b. Small holes
    - c. Small tunnels
    - d. Eaten leaves
    - e. Broken branches
    - f. Fungus plants
        - 1) Looks like tangled pieces of white bread.
        - 2) Looks like rows of shelves.
        - 3) Black, bubbly, hard mass on small branches.
    - g. Aphids — tiny green insects on leaves
    - h. Lichens —
        - 1) Small flat plants.
        - 2) Gold, green, gray, or yellow.

E. Third trip — list and draw signs of companions.

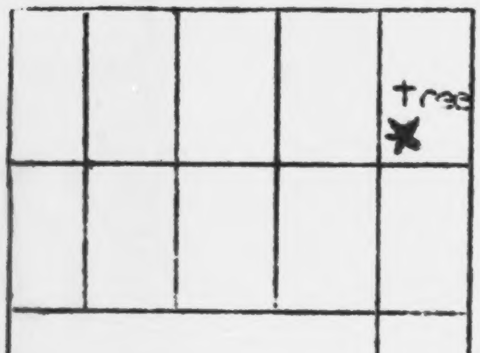
1. Tracks
2. Nests
3. Homes in holes
4. Webs
5. Woodpecker hole
6. Caterpillars
7. Ants
8. Butterflies, moths
9. Other insects
10. Birds
11. Squirrel
12. Owl

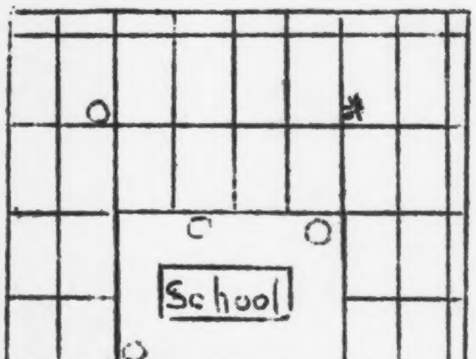
    13. Raccoon
    14. Bat
    15. Droppings

F. Begin putting booklet together either at this time or earlier.
    1. Cover
        a. A design planned by the children.
        b. Drawing of tree, or,
        c. Page of photographs, etc.



    2. Maps
        a. Tree and school
        b. Tree, school, and other trees


tree
School

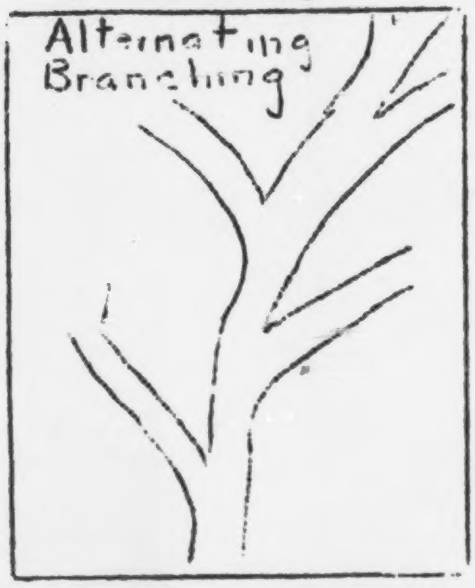

School
O - Trees
* My Tree

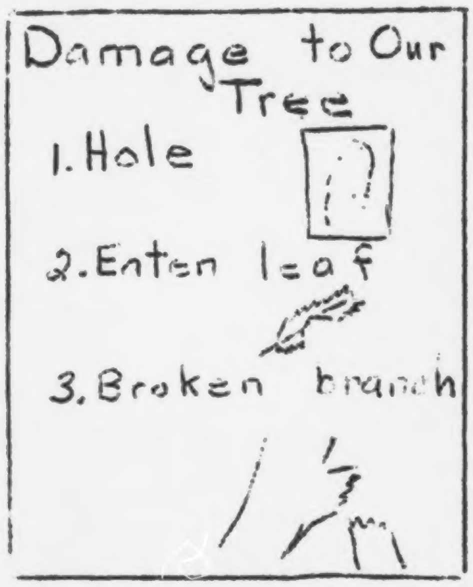
3. Description — written
    a. General size, height
    b. General shape
    c. Leaf color
    d. Bark color
    e. Location
    f. Diameter of trunk, etc.

Our Tree

The tree our group chose is very tall. It is located on the corner of 5th Street and Browns Road. Its leaves spread.

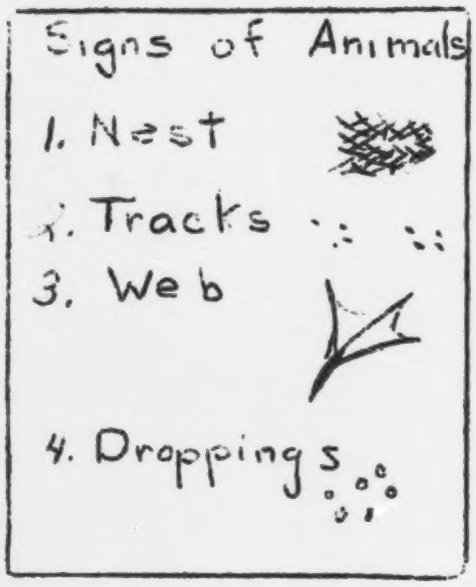
4. Drawing of branching pattern from small branch
    a. Opposite
    b. Alternating


Alternating
Branching


Damage to Our Tree
1. Hole
2. Eaten leaf
3. Broken branch

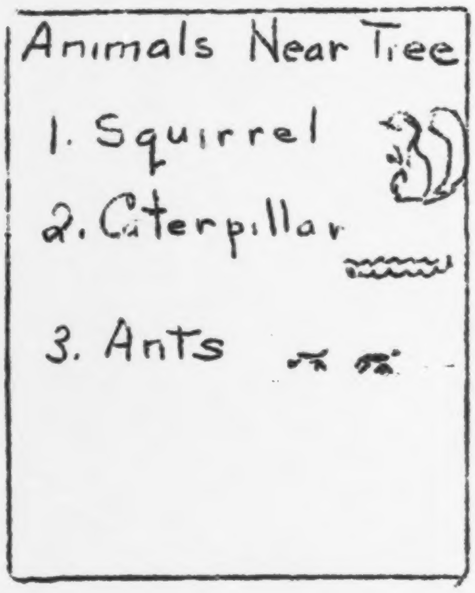
5. List and drawings of damage and possible cause — animal, man, weather, etc. Notice damage to branching pattern.

6. List and drawings of signs of animal companions
   a. Signs of animals
   b. Animals sighted



Signs of Animals

1. Nest
2. Tracks
3. Web
4. Droppings



Animals Near Tree

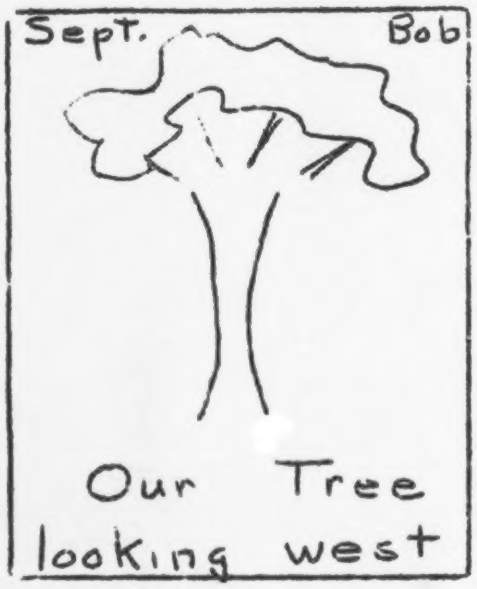
1. Squirrel
2. Caterpillar
3. Ants

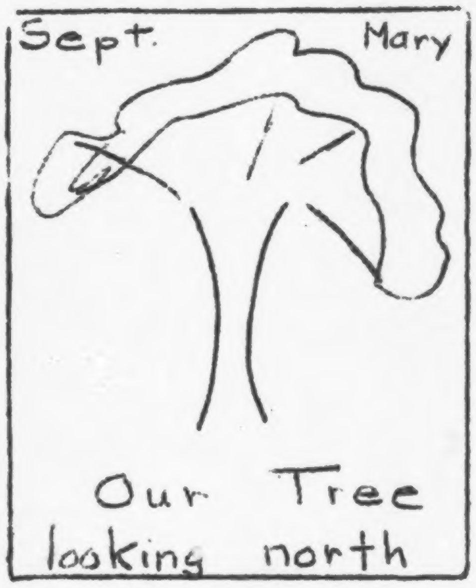
7. This completes the initial study. (The drawings that the children have made and the leaf collection are a part of the extended studies.)

II. Extended Studies

A. Drawings of the tree

1. Nine or ten drawings for those able to visit the tree each month of the school year.
2. Three drawings for those visiting the tree seasonally.
3. Have the children draw the tree from all sides each time the tree is visited.
    a. Scatter the children around the tree at an appropriate distance and draw.
    b. Place groups of children on several sides of the tree where it can be easily viewed for drawing.
4. Place several drawings from "each" trip in each data booklet.
    a. Select drawings.
    b. Label.
        1) Location
        2) Artist
        3) Date
        4) Direction viewed





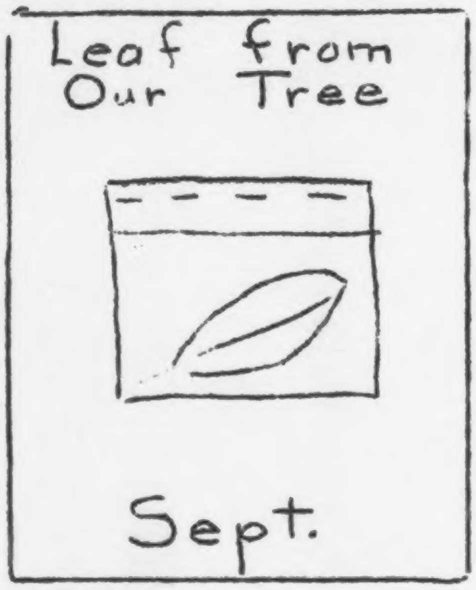
B. Photographs

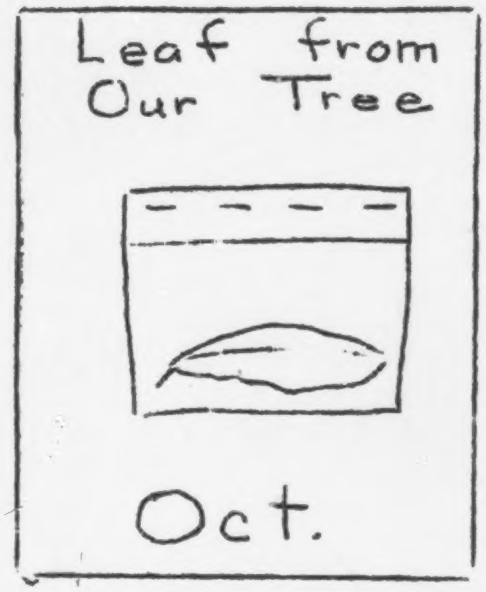
1. Nine or ten — monthly study, or,
2. Three for seasonal study.

3. Take pictures or have children take pictures from several sides of the tree each time the tree is visited.
    a. Perhaps you can get an old Brownie type camera.
    b. Use eight-picture Italian film, when available, (12-15¢).
    c. Have developed right away for high interest.
4. Place photographs on cover or in data booklet or both.
5. You may want to display the extra photos on the bulletin board.

C. Leaf study

1. Five leaf samples — September, October, November, April, and May.
2. Budding branch tip in March and April (adjust this to your growing season).
3. After each trip, place a leaf in a baggie (large or small), seal with a stapler, and staple to a page of the data booklet.
4. Label for month.



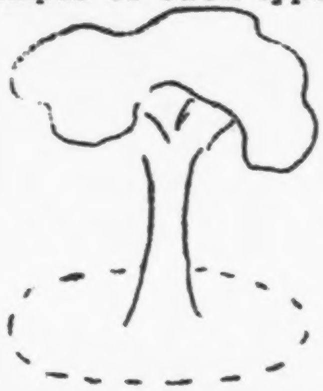


D. Tip of a branch

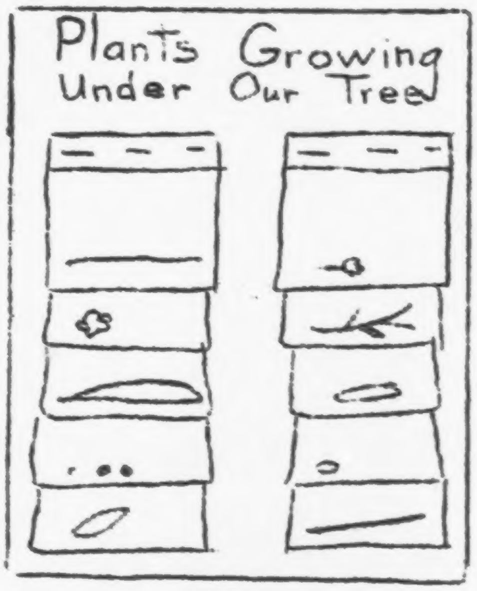
1. Collect a tip end of a branch during six visits — September, October, November, March, April, and May.
2. Place all samples in a baggie and seal.
3. Label for month.
4. Display in the data booklet.
5. Bring a budding twig into the classroom in early March. Keep in water and watch leaf development.

E. Plant companions

1. Two sampling times — Fall and Spring
2. Technique
    a. Select one sample of each type of plant growing under the tree.

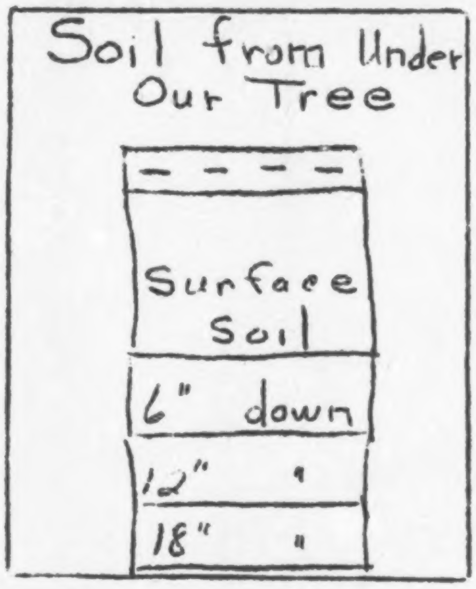


    b. Do this for each data booklet made or each tree studied.
    c. Place each individual sample in a baggie.
    d. Staple closed.
    e. Staple to a piece of paper for the data booklet.
        1) Begin at bottom of page.
        2) Move up an inch or two for the second baggie.
        3) You may get as many as ten on a page clearly visible.
    f. You again may wish to do a sample collection for bulletin board display.



F. Soil Study

1. One time of year.
2. Four or more samples for each booklet or for each tree studied.
3. Technique
    a. Place about a tablespoon of soil in a baggie from each location and depth.
    b. First location — at foot of tree or out about a foot.
    c. Take the following samples:
        1) Surface soil
        2) 6" below surface
        3) 12" below surface
        4) 18" below surface (if possible)
    d. Select several locations around the tree, if you wish, and complete a to c at each location.
    e. Staple the soil sample baggie onto pages of the data booklet. Display the samples from one location on one page, a second location on another page, etc.



    f. Study these soils following the E.S.C. unit on soil.

WATCHING A ROTTING LOG

A dead tree, killed by the activities of the insects and animals and bacteria that it has hosted, is usually filled by a storm or strong wind. The bark may already be off. The plants and animals that continue to inhabit the fallen tree change the wood both physically and chemically. At this stage the inside of the log may be soft and spongy while the outer shell remains firm. In this condition you may find small mammals such as shrews or white footed mice as well as lizards and salamanders living in or near the log.

Finally, the log will disintegrate and become a part of the debris over the soil. In time decay will continue and this log will be a part of the humus layer and then a part of the top soil.

I. Locate a Rotting Log

  A. Examine it for

    1. Animal homes and runways.
    2. Animal droppings — near.
    3. Animal tracks — near.
    4. Insect activity in, on, and under the log.
    5. Fungus.
    6. Lichens.
    7. Moss.

  B. Collect

    1. Animals in jars — transfer to larger jars — feed and water.
    2. Droppings in plastic bags.
    3. Tracks by casting in plaster.
      a. Pour thin plaster of Paris in tracks.
      b. When partially set, place an opened paper clip on or half way into the plaster to serve as a handle.
      c. Allow to set (add salt to plaster for quick setting).
      d. Lift carefully — scrape off soil and dirt.
    4. Insects — locate them and capture as many as possible (a tweezer may help some children). Place in a jar.
    5. Fungus samples — in a plastic bag.
    6. Lichen sample in a plastic bag.
    7. Moss in a plastic bag.

II. Class Study of a Rotting Log

A. Field work

1. Select two rather small rotting logs.
2. Place each in a clear plastic bag, the super large size.
3. Seal it with pins.
4. Place many small pin holes in the bag for air.
5. Select a third log.
   - a. Break it apart.
   - b. Give each child a handful size piece.
   - c. Have each child squeeze their piece and note the amount of moisture held by the lot.

B. Classroom work

1. One log
   - a. Prepare a structure to hold up one plastic bag.
     - 1) Long tinker toys can be used, or,
     - 2) Tall plastic dish detergent bottles work, or,
     - 3) An interior wire structure would be very neat.
   - b. Set the structure inside the plastic bag and reseal.
   - c. Place in a permanent location away from sunlight and heat.
   - d. Watch the log over a period of time for
     - 1) insects
     - 2) plant growth, etc.
   - e. If you wish, you can place the log outside in a cool damp place and continue to watch.
     - 1) deterioration
     - 2) insect activity
2. Second log
   - a. Return the log in the plastic bag to the classroom.
   - b. Open out on the floor and examine.
   - c. Break the log apart into pieces.
   - d. Give each child
     - 1) A piece of rotting log.
     - 2) A hand lens.
     - 3) A tweezer or other prober.

        e. Continue to break the pieces apart.

        f. Collect all insects and place in a killing jar (directions follow).

  C. Materials

    1. Jars (1 qt. if one is to be used for whole class — babyfood jars if each child will have one)

    2. Masking tape

    3. White glue

    4. Isopropyl alcohol — 1 gallon

  D. Procedure

    1. Completely cover outside of jar with tape, wind around from bottom to top.

    2. Pour about 1/2 of isopropyl alcohol into each jar.

    3. Seal them tightly.

  E. Displaying or drying insects

    1. Glue each insect to a 2" x 3" card or construction paper piece.

    2. Display on bulletin board.

    3. Place them in order — any order the children select.

    4. Re-arrange, record, for new approach.

III. Display all items collected from the rotting log including the segment sawed off, a photograph, and a drawing or two of the log at the beginning of the study, insects, etc.

  A. Booklet form

  B. Bulletin board or table display

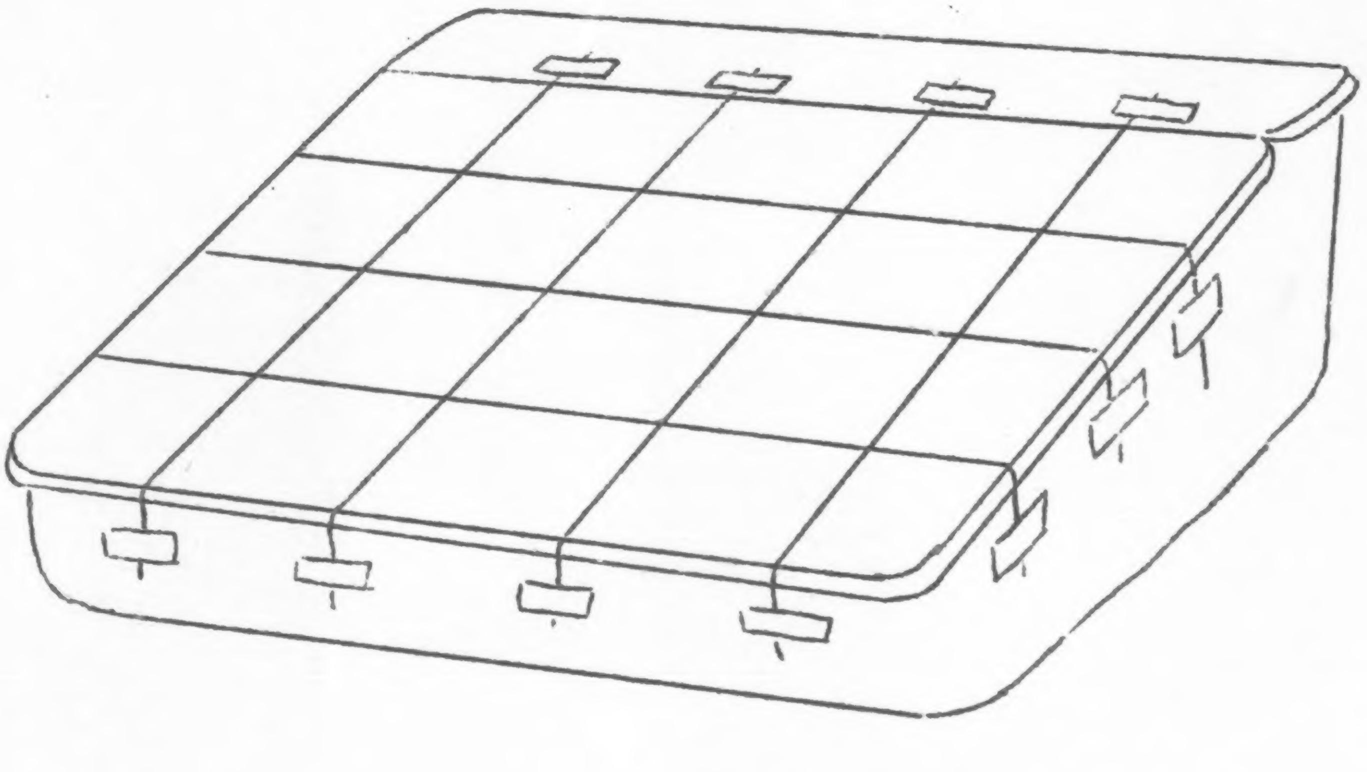
IV. Write an imaginative piece of prose or poetry on "Life in a Log", "My Adventure as a __________________", "How to Live in a Log and Love it", etc.

MAP DRAWING

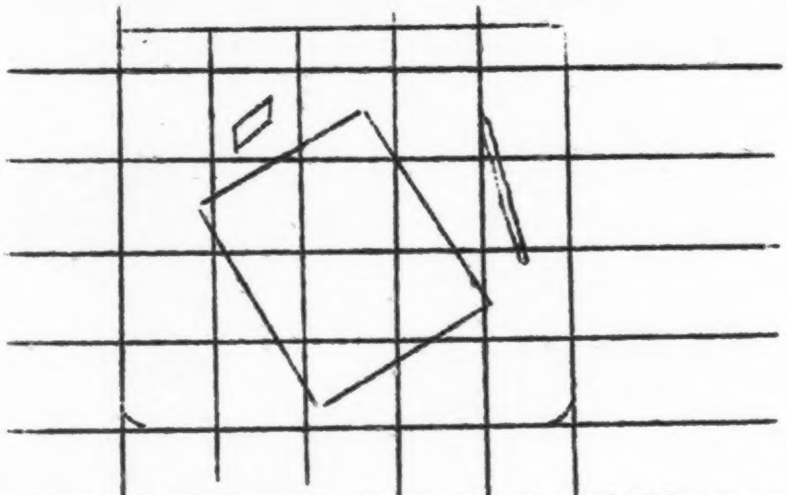
When "drawing" a map we try for more than an artistic rendition of an area. We try to indicate comparative sizes, relative distances, and sometimes direction.

Give the child a very small area to map, at first, like the top of his desk. Give him newsprint paper large enough to cover the top of his desk and his map will be the same "scale" as the desk itself. When he begins drawing in items that he has set out on his desk he runs into difficulty with size, placement, etc. It is a good experience for the child to work with this problem. Many young children can come very close to an accurate map using a ruler, their eyes, and their intuition.

Introducing a grid gives the child a wonderful tool for mapping. In the case of the desk top map a four inch grid may be made across the desk with string and masking tape. Cut string to extend across the desk and other pieces to stretch away from the child across the desk. Anchor the string pieces with masking tape along the side of the desk. Space the string four inches apart going in both directions.



Place several items (pencil, book, eraser, etc.) out on the desk in random fashion. Use one inch graph paper to draw the map of the desk top and the items on it.



It will be very natural for you to "teach" the children to identify each space by placing numerals or letters along the sides of the grid. However, if you do not teach this method of order it will be developed by those who need it. Those who do not need this should not have a chore type task imposed upon them. When they find a need they will make use of the system you suggest or invent a better one.

When the children complete their maps using the grid their results will show more accurate size and spacing relationships.

Now, try the same map using a smaller grid, one half inch. With most classes it is best to do the same map so the idea of scale is very obvious.

By now the children are able to draw a representation of an area, using a grid and using a number and different scales of size.

The next mapping experience can be a table top map, where the children plan a three dimensional setting establishing a grid and mapping on different size grid papers.

Or, if you have a tiled floor, you have a built-in grid for mapping a portion of the room. (Do not attempt to use this as a grid for the whole room unless one or two individuals wish to.)

Establish a perimeter with masking tape and place items on the floor in the area to map. One class put streets on with tape and houses out of block or cardboard. In this case they represented their neighborhood and used the tiles for blocks as well as the grid (blocks were two tiles long and one tile wide).

Next the children will map their classroom using a real grid or an imaginary grid. To establish a real grid the class will need a yardstick (several would be best), masking tape, clothesline, twine or heavy string (approximately 120 yards or more or 1,440 feet).

With the yardstick, mark each yard along all walls starting with one corner of the room. Place a numeral, letter, or other name on the tape. Place the masking tape at eye level so all can see the markings from their desks. From these markers the children should try to imagine the grid that would criss-cross the room. When most children can successfully imagine this grid, maps can be drawn by all members of the class.

If members of the class have difficulty imagining this line it is best to obtain the clothesline, twine, or string to lay the grid line from the markers and then draw the maps.

Either way you do this, please allow a great deal of freedom to move around the room to varify the accuracy of the maps.

Map drawing can now progress outdoors. Grids may be established or marked with stakes, blocks, rocks, etc., or grid lines may be laid with powdered chalk, as the playing fields are marked.

For practical mapping the children will have to depend on imaginary grids. When they go outdoors to the area to be mapped they will establish scale, take measurements, determine angles, etc. Each mapper takes the initiative and responsibility to establish these independently.

GAMES

Grid games, i.e. checkers or chess, can be introduced at any point during these activities.

Grid games can be invented, i.e. set up two players opposite each other, but with a barrier between (notebook set on end, etc.). The first player establishes a grid size, second player draws grid or obtains prepared paper.

Using colored toothpicks, buttons, small blocks, etc. first player places one piece at a time and tells second player where he is putting his piece, he includes name of item, color, and location on the grid. The point is to create an interesting design that is duplicated by player Number 2 by using oral directions only. There are many language and communication skills developed during this "play".

"I KNOW A TREE"

game

This game can be introduced and played at any time during the year.

Step 1 — A child prepares a written description of a tree that is not a part of the class study. Do not include its location. The child will attempt to make his description so clear and include so many details that the class members will be able to positively identify it when they search for it.

Step 2 — Copy the description so each child can carry his copy. Have the children write it or have the originator write it on a ditto master and you run it off for the class.

Step 3 — The search — Either a search trip or an evening or week-end project.

Step 4 — Class evaluates description.

You may use this as an evaluation of the writer's comprehension of the study. The extent of the detail used in the description serves well as a guideline.

It is also possible to use one game as a class evaluation by having all children note any discrepancies in the description or any details omitted that made it difficult for them to make the identification.

WATCHING A DEAD TREE

If you see a tree that has many fungus plants or holes in it, and the bark is peeling off, you be fairly sure that it is dead, even though it may still be standing.

As a branch breaks off of a tree when it is living, a hole is left in its place. Sometimes rain water collects in the hole and the wood around it becomes soft and decays. Insects enter the hole and begin chewing away at the wood, making more holes. Fungus spores fall in and start to grow. A tree can be hollow and still be alive, but as a tree becomes diseased, attacked by other animals and plants, or just weakened from old age, its appearance changes dramatically just before or soon after its death.

I. Locating a Dead Tree
  A. General appearance
  B. Damage to look for
    1. Broken limbs
    2. Holes
      a. Animal homes
        1) Woodpecker
        2) Squirrel
        3) Owl
        4) Raccoon
      b. Feeding holes
        1) Beetle holes and trails
        2) Woodpecker drillings (for bugs)
    3. Loose or torn bark
  C. Plants that live off of the tree
    1. Fungus
      a. looks like tangled pieces of white bread
      b. looks like rows of shelves
      c. looks like black, bubbly hard mass
    2. Lichens

D. Insects who live in a dead tree

   1. Ants

   2. Beetles, etc.

   3. Mosquito larvae in water in the holes

II. Activities

   A. Photograph

   B. List the plants and animals the dead tree supports

   C. Contemplate the life cycle of the tree and write comments in the form of opinions, poems, etc. — Haiku poetry writing would be very usable here (17 syllables).

      Dead tree on a hill
      Waiting to fall in the wind
      Now gives life to ants

   D. Peel off a piece of bark with woodpecker holes (where Woodpecker has drilled for insects). Can you tell where a Woodpecker found a meal? Does he ever guess wrong?

   E. Keep your records

      1. as a supplement to your Tree Watching booklet.

      2. as a bulletin board display.

      3. in any form appropriate to the study and appealing to the children.

ED0 42638

ESC Field Activities

A SURVEY OF LIFE FORMS CLOSELY ASSOCIATED WITH THE SOIL

General

One's first impression of the soil is that it is relatively devoid of activity. Quite to the contrary, many organisms are closely associated with the soil. Animals may build their homes on or under the ground; plants find support and nutrients in the soil. Many soil microbes are found in large numbers. These organisms are important in the continued cycling of nutrients.

Table 1. A representation of the more important groups of organisms that commonly are present in soils. The grouping is very broad and general. Emphasis is placed not on classification, but upon biochemical activity.

Animals	Macro	Subsisting largely on plant materials	Small mammals--squirrels, gophers, woodchucks, mice shrew
			Insects--springtails, ants, beetles, grubs, etc.
			Millipedes
			Sowbugs (woodlice)
			Mites
			Slugs and snails
			Earthworms
		Largely predatory	Moles
			Insects--many ants, beetles, etc.
			Mites, in some cases
			Centipedes
			Spiders
	Micro	Predatory or parasitic or subsisting on plant residues	Nematodes
			Protozoa
			Rotifers
Plants	Roots of higher plants		
	Algae	Green	
		Blue-green	
		Diatoms	
	Fungi	Mushroom fungi	
		Yeasts	
		Molds	
	Actinomycetes of many kinds		
	Bacteria	Aerobic Anaerobic	and Autotrophic Heterotrophic

SE 009 754

Plant and animal interrelationships are necessarily influenced by the soil type and its constituents. In addition to the above, climate and other environmental factors combine to dictate rather well-defined limitations in reference to life forms. The delicate set of circumstances might well be imagined as a standing row of dominoes - to tip one down results in a position change as the others interact with the falling domino. In Figure 1 it can be seen that environmental factors influence the distribution of soil types and that the combination of these factors will modify plant species distribution. Animals dependent upon certain plants for food and protection will necessarily reflect a distribution which compliments that of the plant cover.

Conducting the Survey

A survey of this type may be conducted on virtually any type of soil habitat - grassland, woodlot, or marsh area. The types of plants, animals and soil will vary in each case. It is not necessary to identify organisms taxonomically in order to demonstrate the concept of interrelationship. A listing of the variety of life forms will suffice in most preliminary activities. For contrasting studies between one or more types of soil habitats, an index of different forms in addition to variety found within the individual samples will prove to be most interesting.

It is suggested that the investigator sketch the area he is studying and locate his sample sites on the map. A small sample plot (quadrant) should be used and one meter is recommended as a standard size. The plant types found growing in the quadrant can be assorted according to numbers of similar individuals, numbers of different kinds, or an index reflecting both sets of data. As the skills of the investigators become more sophisticated, the study can reflect more specific information.

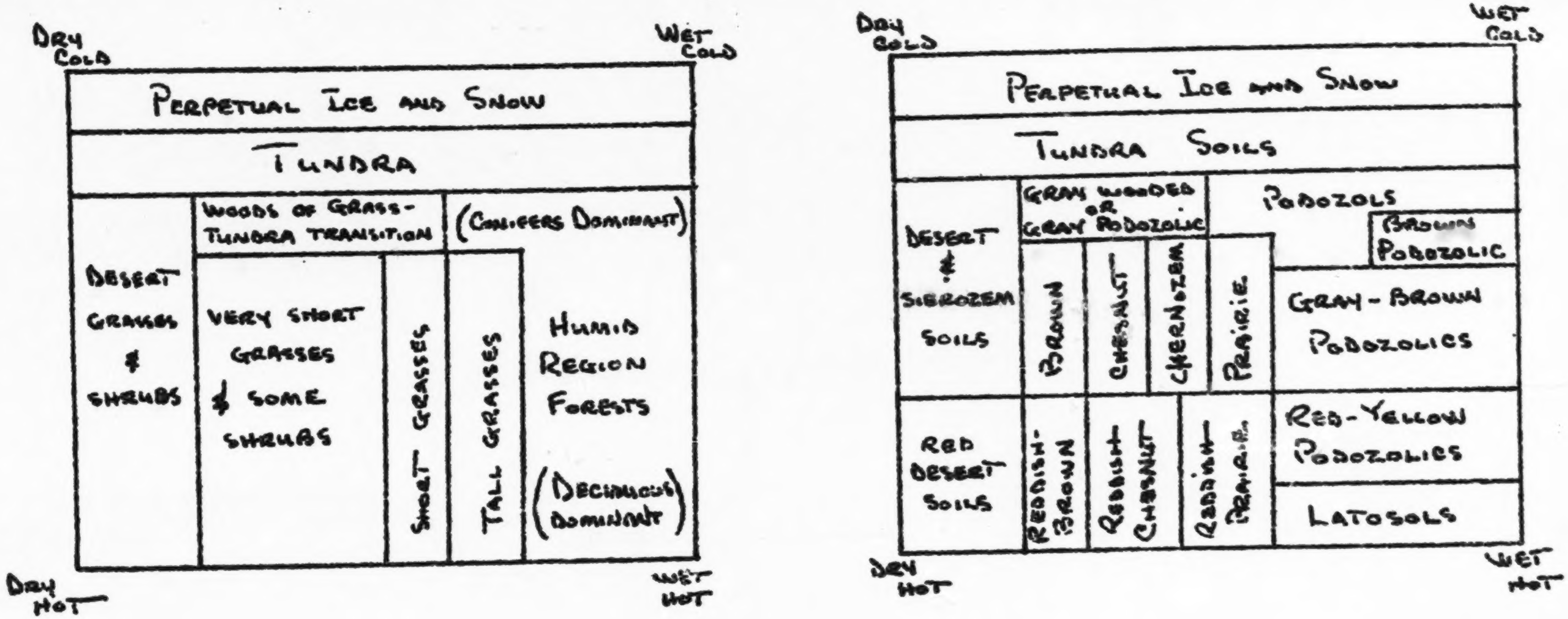

DRY COLD
WET COLD
PERPETUAL ICE AND SNOW
TUNDRA
WOODS OF GRASS-TUNDRA TRANSITION
(CONIFERS DOMINANT)
DESERT GRASSES & SHRUBS
VERY SHORT GRASSES & SOME SHRUBS
SHORT GRASSES
TALL GRASSES
HUMID REGION FORESTS
(DECIDUOUS DOMINANT)
DRY HOT
WET HOT
DRY COLD
WET COLD
PERPETUAL ICE AND SNOW
TUNDRA SOILS
GRAY WOODED OR GRAY PODOZOLIC
PODOZOLS
BROWN PODOZOLIC
DESERT & SIEROZEM SOILS
BROWN
CHESNUT
CHERNOZEM
PRAIRIE
GRAY-BROWN PODOZOLICS
RED DESERT SOILS
REDDISH-BROWN
REDDISH CHESNUT
REDDISH PRAIRIE
RED-YELLOW PODOZOLICS
LATOSOLS
DRY HOT
WET HOT

Figure 1. A simplified diagram showing how the natural vegetation and zonal soil varies with climate. Soil boundaries correspond rather closely to those of the natural vegetation. The right to left successions of soils and vegetation shown in the diagrams approximate those that will be encountered when travelling from the east coast of North America to the Sierra Nevada and Cascade Mountains. Typical desert conditions occur in the intermountain regions west of the Rockies.

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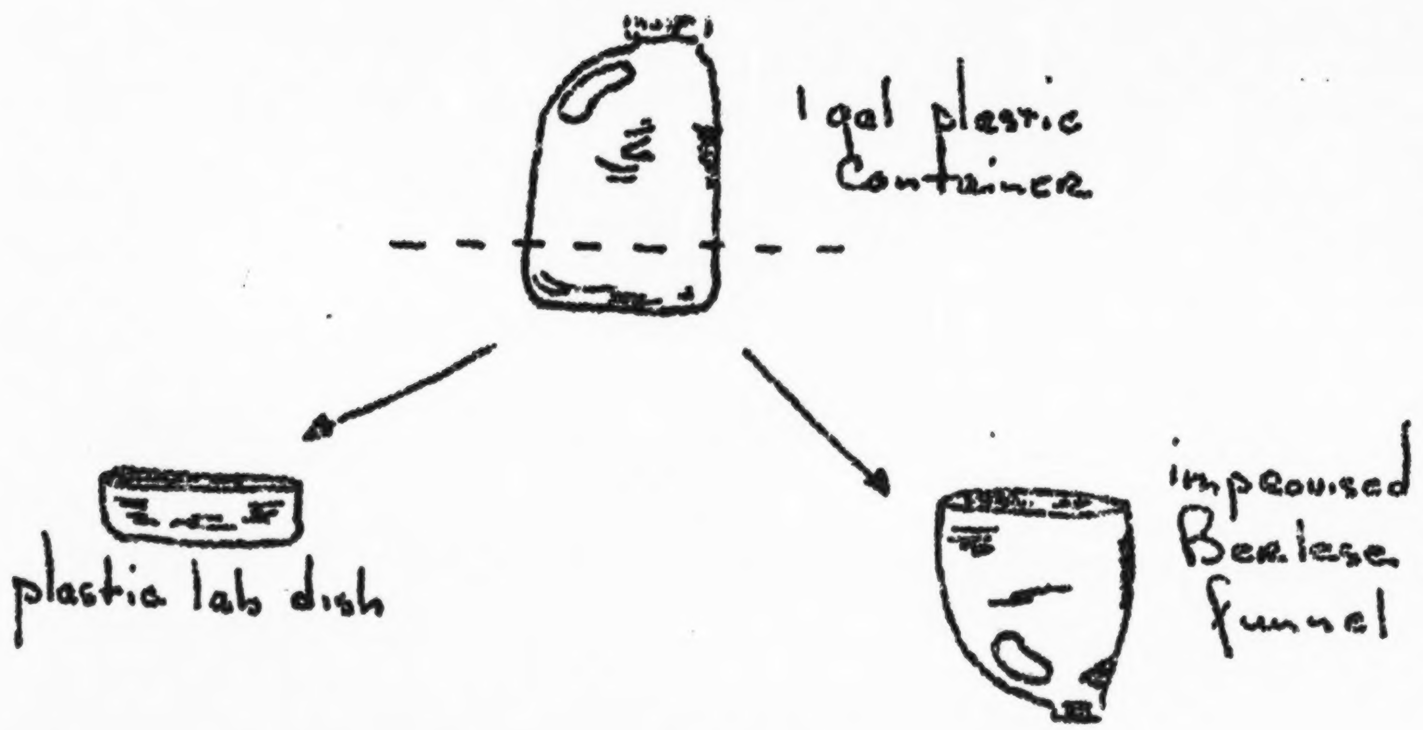
1 gal plastic Container
plastic lab dish
improvised Berlese funnel

Figure 2. Use of plastic containers to improvise a Berlese funnel and lab specimen dish.

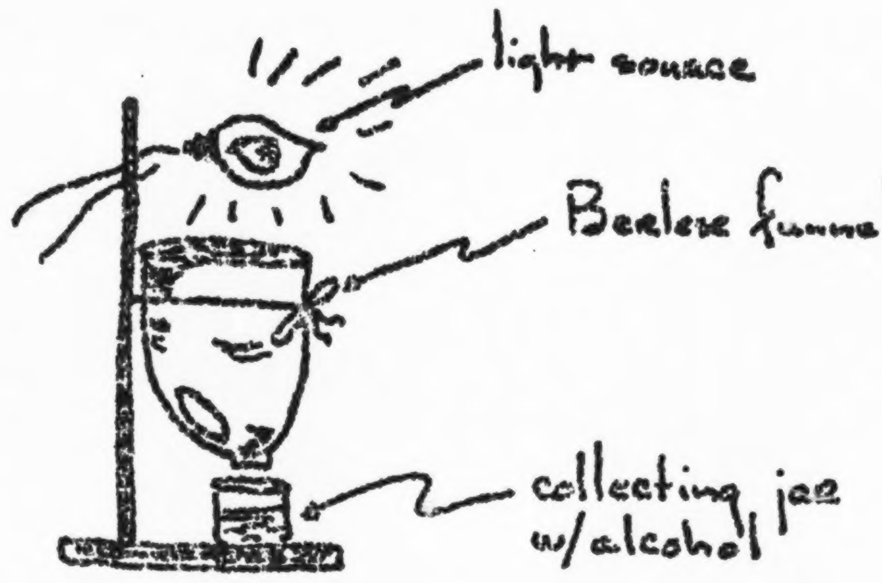
light source
Berlese funnel
collecting jar w/alcohol

Figure 3. Suggested set-up for improvided Berlese funnel.

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To obtain a sample of the macroscopic life forms present in any given soil sample, one can make use of a simple device called a Berlese funnel. The construction and use is illustrated in Figures 2 and 3. Samples should consist of soil taken up to a depth of about 7 in. In principle, as the light source heats and drys the soil, the inhabitants are progressively driven deeper until they fall into the collecting jar containing alcohol. Sorting of the preserved specimens can be accomplished at the investigator's convenience.

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[1] Buckman, H.O. and N.C. Brady. 1967. The nature and properties of soils, The Macmillan Co.: New York

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Revised 4/3/69

PLANT PUZZLES

Environmental Science Center
5400 Glenwood Avenue
Golden Valley, Minnesota 55422

9754

Introduction

Natural objects and areas are characterized by structural organization. These may be fit together like pieces of a puzzle making them an organized and somewhat predictable system. This is a concept which children should become aware of at an early age. It makes their study of our environment less formidable. The activities of this lesson are intended to familiarize children with some of these patterns, their variety and the constancy with which they are repeated. To accomplish this, children will work with a number of branches. They will examine their external structures and characteristics. They will also study the internal pattern of the stem. Relationships between external characteristics and internal patterns will become apparent during this examination. For example, the children will see that a branch will cause an interruption or variation in the internal pattern of the stem; or that the number of rings in a woody stem cross-section decreases from the bottom to the top.

The children will examine external characteristics of their branches such as the buds, leaf scars, the bark color and texture, pores in the bark, and leaves.

Buds occur at the point of leaf and stem junctions and are the forerunners of branches, leaves, and flowers. The bark forms a protective covering for a plant. Because the bark is relatively impermeable, pores are formed for the passage of gases to and from the living tissue within. These pores are especially conspicuous on smooth barked branches and appear as tiny, hard "pimples."

The internal pattern of the branch will be revealed by cutting the branch with a pruning shears. The ring pattern found in a branch cross-section is formed from different types of tissue which provide support and serve to conduct plant nutrients up and down the stem and out into the branches, leaves, buds, and flowers. One ring is added for each year of growth.

Materials:

pruning shears (one to six)

quart milk cartons (one per child)

large cardboard box (one)

cardboard string tags (two per child)

shallow cardboard box (large enough to hold all milk cartons)

rubber bands (one box)

I. Collecting the Small Branches

If these activities are started in March or early April the children will see leaves and flowers appear from buds on the branches they collect.

Ask the children to bring two branches from home. These branches should be (1) as long as his arm; (2) both from the same tree or bush; and (3) "interesting." The word "interesting" is mentioned to help insure that you won't have a selection of all "willow branches." Variety is very desirable. You might send home the following note for the parents so they are aware of what their children are doing and may assist them in getting the branches. (Warn the children against selecting branches from their neighbors' prize rose bush.)

Dear Parent:

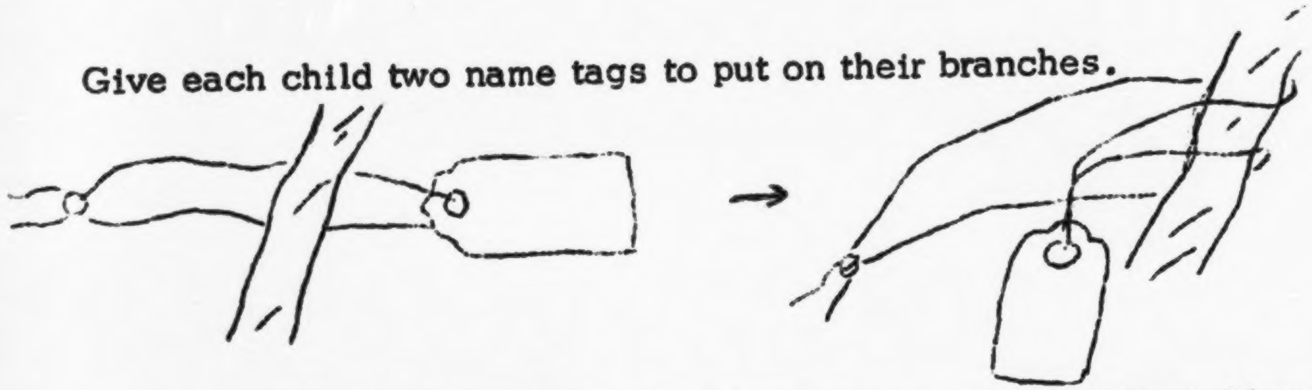
Please help your child collect two branches, both from the same tree or bush. Cut branches that are as much alike as possible. They should be about as long as your child's arm. If they are branched they will be more interesting to study. Roll them in newspaper so they can be carried to school easily.

He also needs a quart milk carton. We need these for class on ______________.

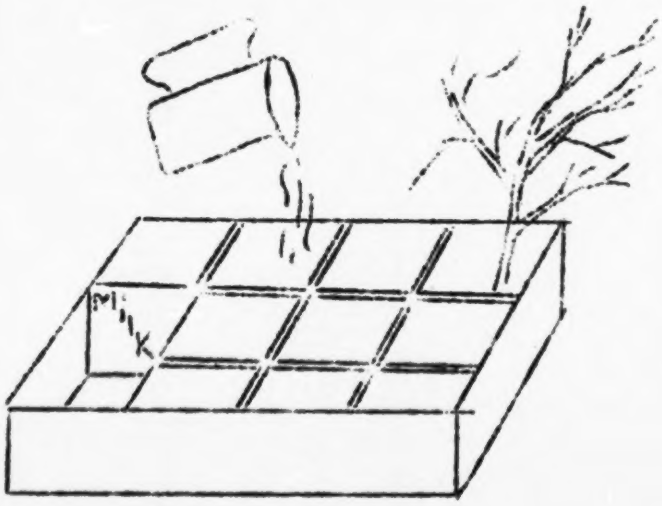
Thank you.

When the children have brought their branches to school have them select one branch to watch leaf out. The other branch will be handled a lot and may be injured. This second branch will actually be cut up in a later activity. They might put a piece of tape around the top of the branch they want to save to watch leaf out. They can then place both the branches in their quart milk carton.

Give each child two name tags to put on their branches.



These milk cartons can be placed in rows in a large cardboard box so they don't tip over. Keep the box in a window so the branches receive sunlight.



II. Small Branches in the Classroom

A. What branch am I thinking of?

1. Have the children lay their branches on their desks where you can easily see them.
2. Walk around the room and select a branch. Without pointing it out or telling the children which branch you are thinking of, describe some of its easily noticeable characteristics. Describe such things as color of bark, the buds, size of branch, etc.
3. Have them try to guess whose branch you are thinking of.

This activity starts the children looking at the immediate outward appearance of their branches.

B. Charts and drawings

1. Pass out the booklets and have the children fill in the charts and drawings by examining their branches. The pages for this booklet are found in the appendix. Following is a description of these pages.

   Page 1 — Circle the drawing which is most similar to your branch.
   Type of Buds (three sketches)
   Arrangement of Buds (three sketches)

   Page 2 — Circle the drawing which is most similar to your branch.
   Leaf Scars (six sketches)

   Page 3 — Circle the drawing which is most similar to your branch.
   Branch Arrangement (three sketches)

   Page 4 — 1. Do this page when leaves come out of the buds on your branch.

   2. Take a leaf from your branch and trace around it. This makes an outline of the leaf.

   3. Look at the leaf closely. What do you see? Draw what you see inside the outline of the leaf.

   Page 5 — Make a drawing of your branch on this page. First tape the branch to the top of your desk so it will not move. Draw just the side of the branch that faces you.

2. Have the children check the first three pages of each other's booklets by exchanging both the booklet and their branch. (This will expose them to a variety of branches.) If they disagree with the answer in a booklet they should discuss it with the owner. They can initial each booklet they check.

C. Can you find the bottom piece of your branch?

1. Using the pruning shears, cut one inch off the bottom of each child's branch. Collect the pieces in a box.
2. Have the children gather around a table.
3. Spill the end pieces from the box onto the table. (It is usually quite a surprise to see the variety of bark colors in such a display.)
4. Have the children see if they can retrieve the piece taken from their branch. (They may have to match it up with the top part of their branch.)
5. Can they match the end piece up with the branch exactly as it was when it was cut away?

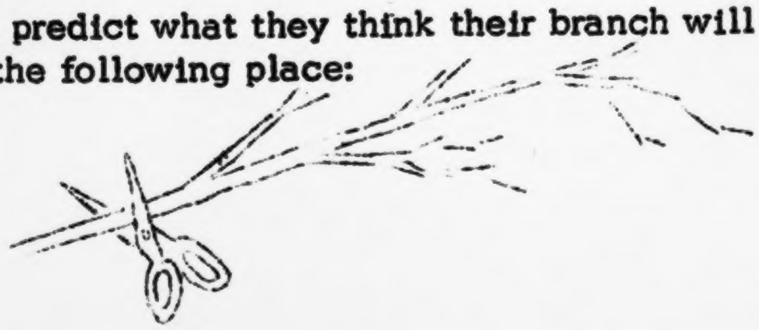
This activity emphasizes the bark color. As the children try to match the cut ends it causes the children to look more closely at other characteristics of the bark (markings, etc.) and possibly at the ring pattern exposed by the cut.

C. Radio broadcast

1. Set up the broadcasting station in the front of the classroom in the following manner:
    a. Get a large cardboard box (T.V. box, etc.).
    b. Set a tape recorder-amplifier inside the box.
2. Collect one of each child's two branches and put them in a container. Set the container inside the broadcasting station.
3. Number the milk cartons containing the other branch (the one selected to leaf out). Use large numbers and set the individual milk cartons around the room where the class can easily see both the branch and its number.
4. Select a child to start the activity and have him get inside the radio station.
5. This child takes one branch from the container inside the station (not necessarily his own branch) and describes it over the loudspeaker. (By this time, he should be familiar with many characteristics he could describe. For example, he might recall the charts he filled out and describe buds, branches, etc.)
6. As soon as a child in the audience feels he knows which branch is being described he should raise his hand and give the number of the branch which is the same as the one being described. If the child is wrong, the broadcaster continues. If the child is correct, he gets to broadcast a description of a branch.

D. Making a plant puzzle

1. Have the children predict what they think their branch will look like when it is cut in the following place:



Have them make a circle and draw what they think it will look like inside the circle. They should label the drawing "imaginary."

2. As they finish their drawing they raise their hand and you cut the branch for them with the pruning shears. (Use the branch which isn't being saved.)
3. Have them draw what it actually looks like now that they can see it. Label this drawing "real" and compare it with the "imaginary" drawing.

III. Big Branches

A. Get some large branches or small trees. These can be obtained from commercial tree trimmers or you might gather them yourself from a wooded area in the country. Try to get a variety of types.

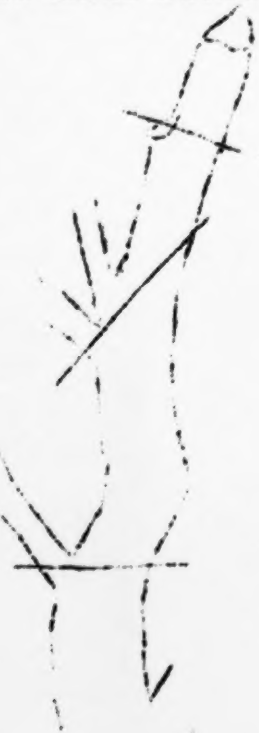
B. Using a bandsaw, cut the branches into pieces about one to two feet in length. Have no more than four or five pieces to a puzzle. If the branch is quite large you might make a couple of puzzles from a branch. Small, full branches might be trimmed and the trimmings discarded. Make most of your cuts across areas where branches leave the stem or injuries or growths are noticed. The pattern of the ring structure will be quite interesting and unusual in these areas.

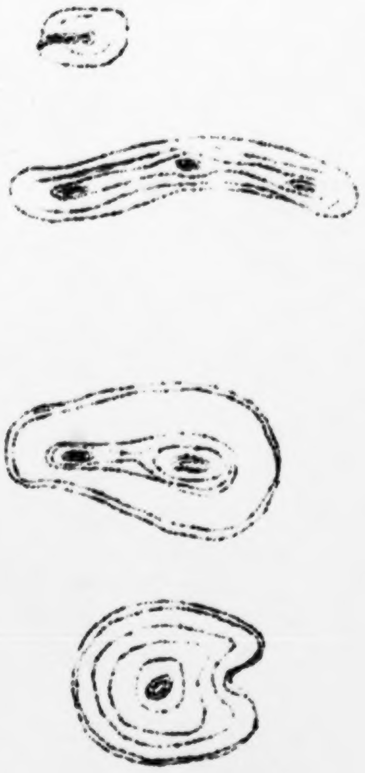
C. Put the pieces from each puzzle in bags. Assign one bag to each pair of children. (If you have made only a couple puzzles, you might handle it as an individual activity where a child constructs the puzzle during his free time.)

D. Have them reconstruct the branch or tree. If you have made several puzzles from a single branch, they should find the other puzzles from their branch and join them together to form the complete branch.

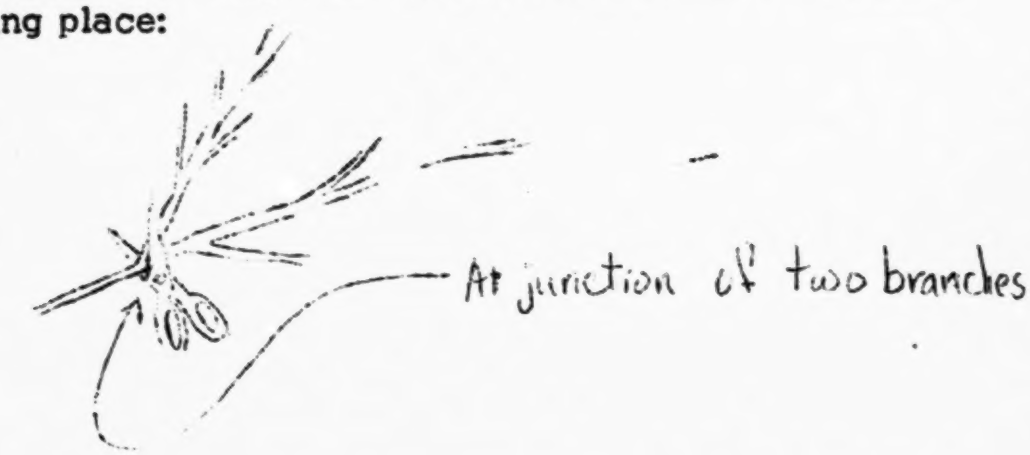
E. Discuss the varying internal patterns the children found. Can they tell why the pattern is so different in a spot where a branch has left as compared with a spot where there is no branch?

F. Have the groups exchange puzzles and construct them. What comparisons can be made between internal patterns of different types of trees?





4. Now, can they predict what they think the branch will look like when cut in the following place:


At junction of two branches

They should make a drawing of their prediction. Label this drawing "imaginary."

5. As they finish their drawing, cut the branch for them and have them make a drawing of what it actually looks like. Label this drawing "real" and compare it with the "imaginary."

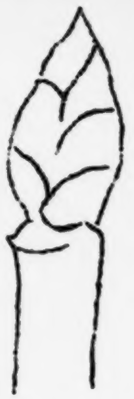
6. Have them select three more spots they would like to cut across and examine. (If you have extra pruning shears you might have some other children help make these cuts.)

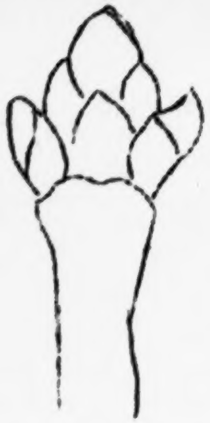
7. Pass out rubber bands. The children can fasten their name tag to the rubber band and gather the five pieces of their branch together with the rubber band. This is their plant puzzle.

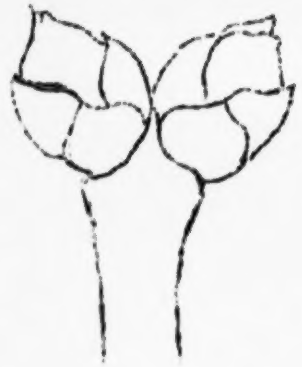
8. Ask them to exchange their puzzles with each other and see if they can reconstruct them. If they have trouble they should get help from the maker of the puzzle.

This activity starts the children looking at internal characteristics and patterns and how they can change in relation to the external characteristics they have been studying.

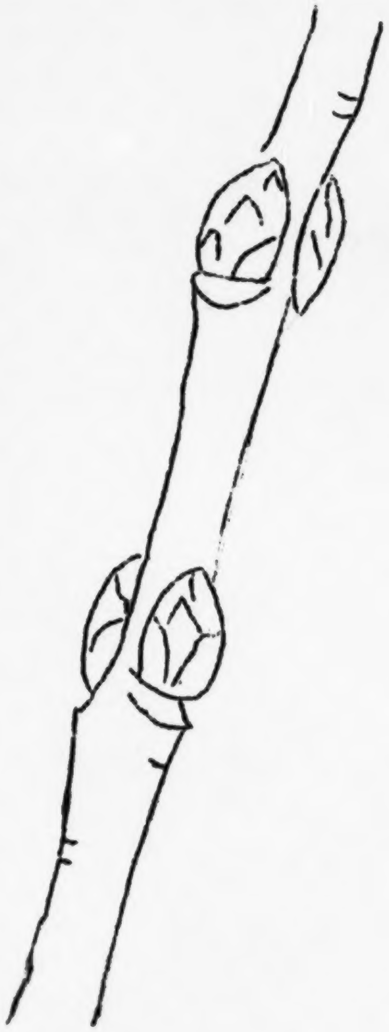
Page 1
Circle the pictures which look most like the arrangement of buds on your branch.

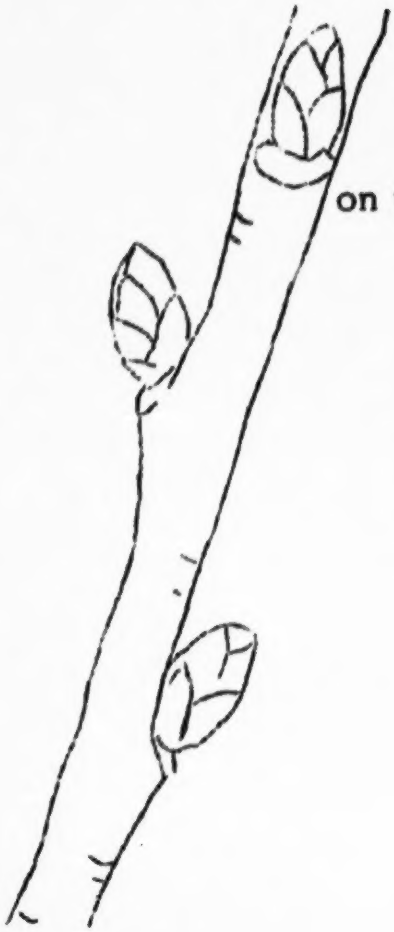






on the end



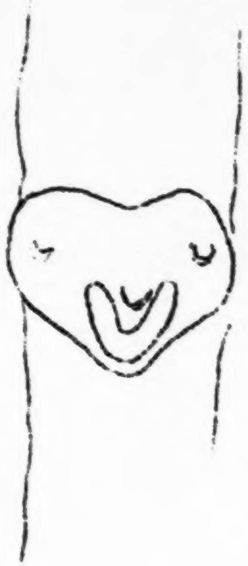


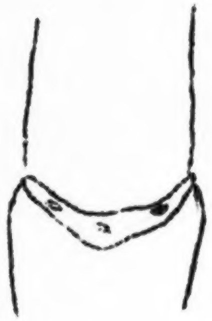
on the side

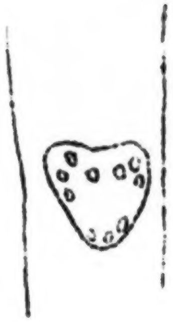
Drawings from E. S. S.
"Budding Twigs"

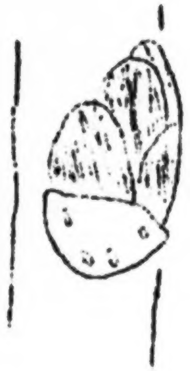
Page 2

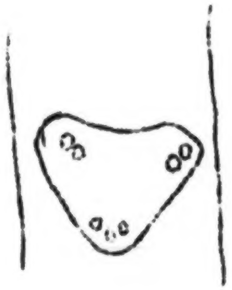
Circle the leaf scar that looks most like the leaf scars on your branch.











Page 3

1. Do this page when leaves come out of the buds on your branch.
2. Take a leaf from your branch and trace around it. This makes an outline of the leaf.
3. Look at the leaf closely. What do you see? Draw what you see inside the outline of the leaf.

Make a drawing of your branch on this page. First tape the branch to the top of your desk so it will not move. Draw just the side of the branch that faces you.

ED0 42638

Environmental Science Center

KFL 4/24/58

VARIATION WITHIN A SPECIES

Background

Ecology begins with observations on plants and animals in the area they inhabit. Environmental factors can be measured simultaneously so that correlations can be made between animal behavior, plant and animal structure, and the environment. It is found that modifications occur in form and in modes of behavior as available water, temperature, light, soil, wind, etc. change. Thus, over long periods of time, adjustments may result in changes which are inheritable and may partially account for the diversity of plant and animal types (species). Plant and animal type changes also occur within a relatively short time as a result of environmental pressures. These changes are not hereditary. For this reason, plant and animal species are not uniform in their behavior and structure in all areas where they are found.

This lesson shows some of the variation that exists within a life type. Our investigation will be limited to a member of the plant kingdom, but the conclusions drawn and the concepts developed can be extended to the animal kingdom and still retain general validity. Variations studied in this lesson are those the children can identify in their own plants. They may find variables such as leaf number, leaf length and breadth, leaf area and plant weight. The two areas of study which could be pursued to account for these variations are: 1) environmental conditions, and 2) heredity. However, the purpose of this lesson is to show that variation exists, and not why it exists.

Materials

Item	Source	Quantity
Scissors (round point)	School	one per student
Scale or balance (opt.)	School	two
Plastic bags	Grocery store	one per student
Rulers (centimeter)	School	one per student
Graph paper	School	ten per student

During the course of this lesson children will become familiar with collection techniques, quantitative methods of measuring the variations studied, the importance of keeping records, the use of graphs as a means of showing variation and comparing variations. The concepts which will be focused upon are: 1) life exhibits variety even within a species, and 2) the range of this variety is predictable and limited.

This lesson is most appropriately used as an outdoor activity in the spring or fall. If potted plants can be obtained in the quantities required, the activity could be used in the classroom during the winter.

Procedure

I. Pre-Field Trip

Whenever possible, the lesson should be conducted so that the direction comes from the children. The class will proceed from a general survey of several plant types in a study area to a specific study of a single plant type. The general survey will introduce them to the idea that variation exists between all species observed. The specific study will measure these variations as they exist in one selected plant species. The site you select for this study can be any grassy area easily accessible to your class. It will be necessary to remove plant specimens from this area and you may have to get permission to do this. The plant chosen for the second phase of this lesson will be collected most extensively. Suggested plants are dandelion or plantain. There are three reasons for these suggestions. Dandelion and plantain grow profusely under a variety of conditions so they are usually available; their large broad leaves are easily handled and studied; and the removal of these plants probably won't be regretted by the caretaker of the grounds.

A map of the study site should be made if you are planning to do the "related studies" listed at the conclusion of this lesson. The class will use the map to record the location of the plantain or dandelion, so it should be drawn in large scale. Include on this map all prominent objects, structures and plants which project above the grass level. (Figure 1.) A free hand sketch will suffice; however you may want the class to prepare a more accurate map as an exercise for the Environmental Science Center's lesson entitled "Mapping".

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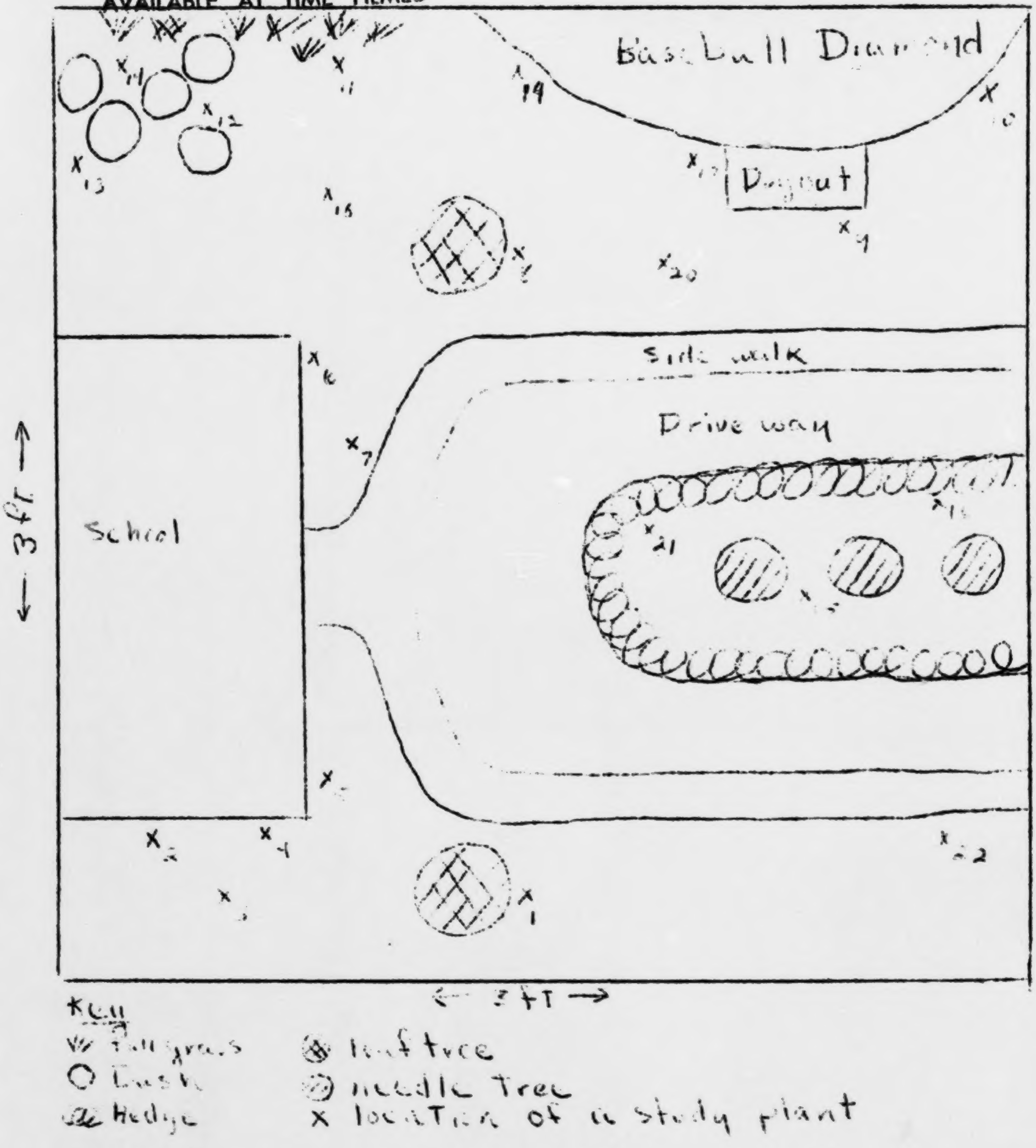
Baseball Diamond
Dugout
Side walk
Drive way
School
3 ft
3 ft
Key
tall grass
bush
Hedge
leaf tree
needle tree
x location of a study plant

Figure 1. Site Map

II. Field Trip

Part 1.

The initial activity will be a general survey of the plant types of the study site. Have the children spread over the area and collect as many different leaf types as they can locate. A good background for the examination of these leaves can be made by staking down an old sheet in a central location. Provide straight pins or scotch tape so they can attach their leaves to the sheet as they collect them.

When the children have finished collecting leaves, gather the class around the sheet and play a "matching game" with the leaves. To demonstrate the game, have one child pick up a leaf near him and see if he can find another leaf of the same kind to match it. What reasoning did he use to decide the second leaf was the same as the first? Did he use color, shape, size? Ask for volunteers to match the remaining leaves, expressing the criteria they used to do so. The result will be groups of distinct leaf types (species). Now that the children have noted common characteristics which determine leaf types, begin to point out characteristics which vary _within_ a leaf type. Pick up one of the leaf groups, and ask a child to select one leaf from the group. Put it back into the group and shuffle them. Ask him to again select the leaf from the group. How did he determine which was the correct leaf? Does this leaf have a slightly different size? ... shape? ... color? Now ask the class to pair off and select leaf groups from the sheet. If sufficient groups aren't available they may pick more leaves from the surrounding area. Have them examine their leaves, noting differences among members of the group. As the teams finish observing their leaves, they may exchange groups. After each team has observed several leaf groups, ask them what differences (variations) they found. When these have been listed, hold up one group as an example and ask a volunteer to state the variations that exist within that group that enables him to differentiate between the leaves.

You may want to reaffirm the fact that they are still working with distinct leaf types by the following procedure. As he is describing variations slip another leaf type (species) into the group. When the class notices this, ask what characteristics of this leaf makes it obviously not a member of the group. The important fact is that within a leaf type species there _is_ variation, but the characteristics of a species are such that one easily recognizes a leaf which is not a member of that leaf's species.*

Part 2.

Proceed to a more specific study of your area now by concentrating on the collection of one plant species. As mentioned earlier, either dandelion or plantain (Fig. 3) can be used for this phase. Another plant may be selected if plantain is not available in quantity. Examine the group of plantain or dandelion leaves from the sheet collection. The children may list the variations they see in these leaves. Ask if they can look at this small group of leaves and determine what characteristics (size, shape, etc.) the most "average" leaf for this plant would have. Are all possible variations in any given characteristic represented within this group? Are they certain? How might they find out?

To take a more complete sampling, provide the children with blunt-nosed scissors, string tags, and plastic bags. Ask them to re-survey the area, this time searching specifically for dandelion or plantain. One plant per child should suffice. When collecting their plant they should remove it as a whole with the leaves intact. This will require that they cut the plant away close to the ground. Why should each child collect and cut in much the same way? (When they eventually compare variations such as weight, the importance of having used the same technique will become apparent.)

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*This might be related to the fact that the children can differentiate between a poodle and a collie although both are dogs.

The child's name should be on a tag along with the date of collection. These tags may then be affixed to each plant. (See Figure 2) The plant's location may now be marked on the site map if one is used. Place the plants in plastic bags to prevent drying out while transporting them to the classroom. Plant freshness can be further insure by sprinkling them with water.

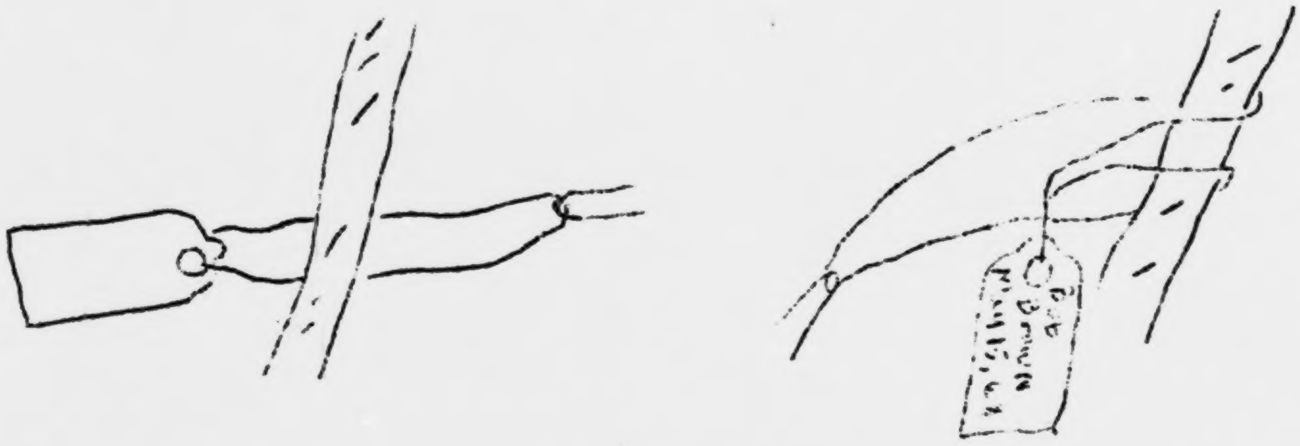

Figure 2. Plant Tags

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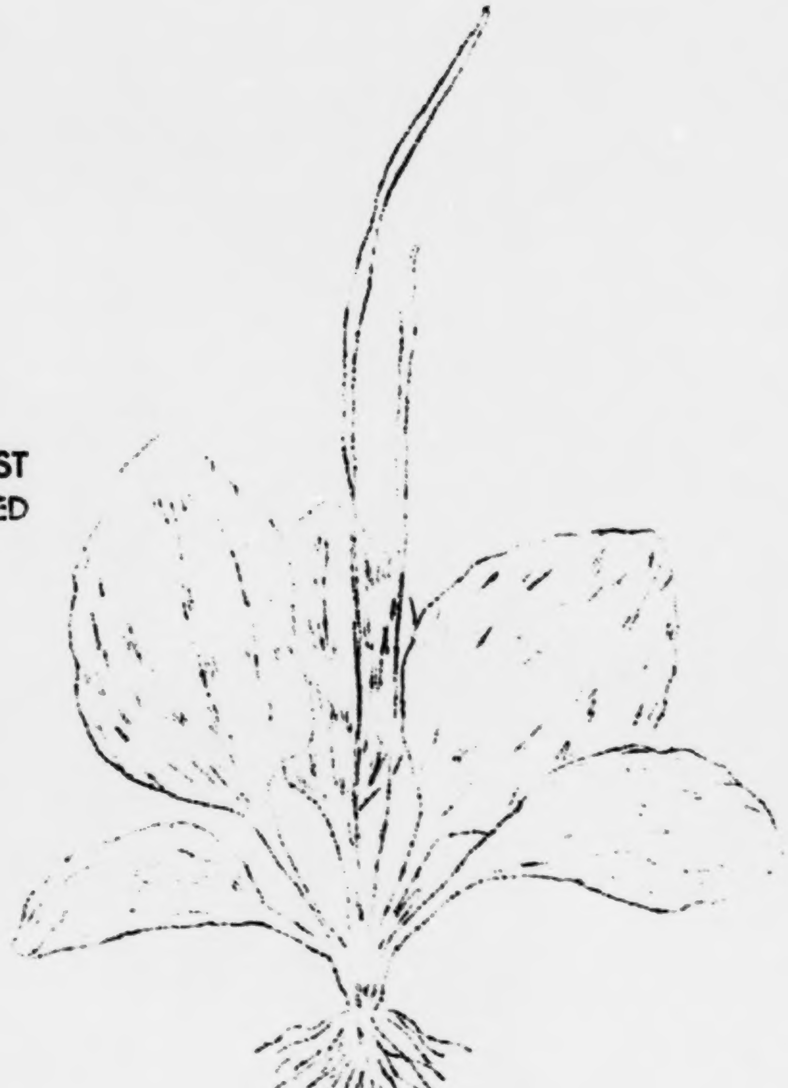

Figure 3. Plantain*

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* Weeds of the North Central States, Buchholtz; North Central Regional Publication No. 36; 1960, p.151.

III. Classroom Activities

Part 1. Observation and Measurement.

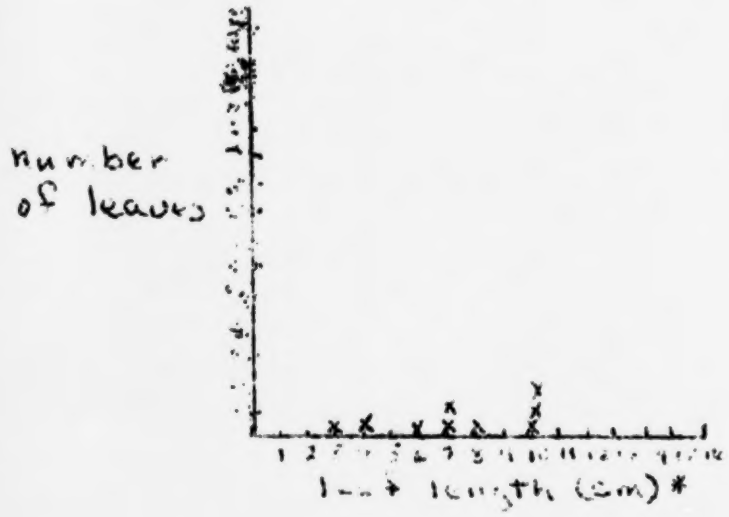
After the children have examined their plants ask them to state some of the variations they observe. List these on the board and ask them to find who has the extremes of these variations. For example, "who has the longest leaf?" In order to find an answer to this question, they will be required to compare leaves. Comparisons are best made by measurement, however measurement may not be suggested as a means of an swering the question. Perhaps if equipment such as balances, graph paper, and rulers are arrayed on a table, some ideas for measurement will occur to them. If some variations not anticipated are suggested, other materials for measurement may be required.

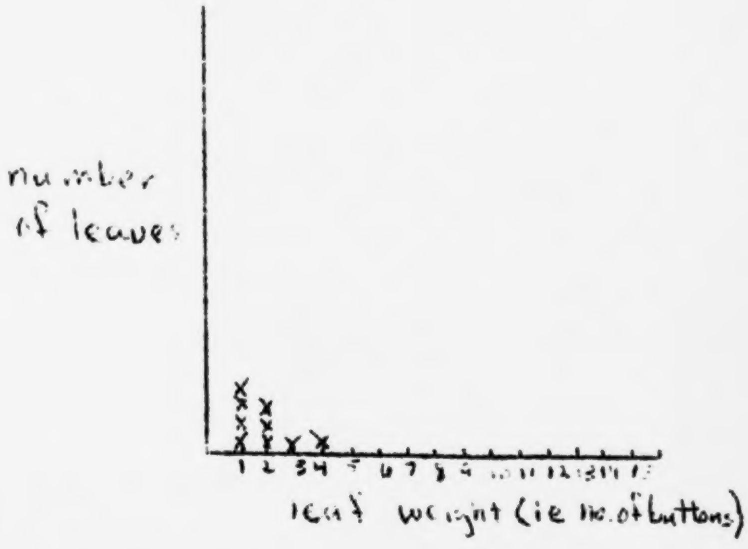
In order to make comparisons, one method of measuring a certain variation must be employed at sometime. All ow the children to try a variety of methods and then establish one method for the measurement of each variation you intend to compare on graphs. This can be done by circulating among the students and picking out those who are using the most effective procedures for these measurements. Point these procedures out as models which the rest of the children might observe and use or refine. Variations which your class may find difficult or impossible to measure quantitatively are leaf shape and leaf color.

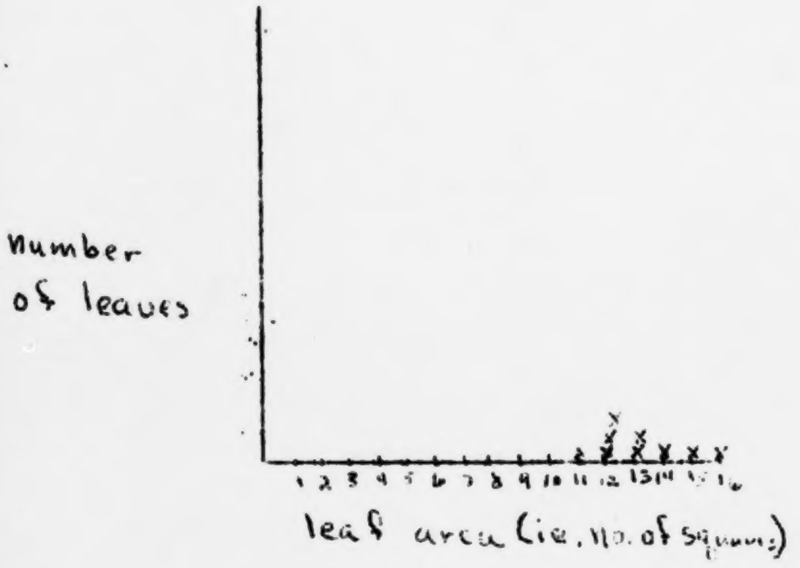
Whatever measurements are made should be recorded. Record keeping is a natural requirement for science. The children will find it necessary to record their measurements and other information in a notebook. Do not set forth a specific format for notebooks, as the children should not be restricted to keeping notes in only one way or about only certain things. They may see importance in recording information seemingly unrelated to the point of the lesson. This should not be discouraged. After the class has made their measurements, each child can construct his own histograms from the data recorded in his notebook.

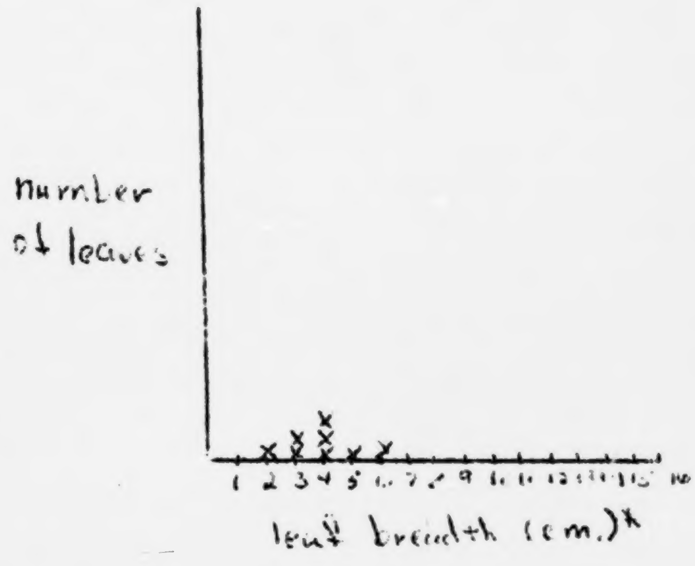
Part 2. Graphing Individual Histograms.

The variations selected for study on histograms should be those which have been measured in the same way by the entire class. Provide the children with graph paper and ask that they make one square equal to one unit of the variation measured. Individual histograms such as the following can be made.









Following are methods which could be used for the determination of leaf area and weight. Your class may devise others.

Leaf area can be approximated in two ways. The children could outline their leaf on graph paper. They then count all the whole squares inside the outline, and count every other square which is only part inside the outline. Of course, if your class is familiar with fractions they can use these. The second method requires they make an outline of the leaf on drawing paper. The children fill in this outline with peas and count the number of peas used.

Leaf weight can be approximated if a balance scale is not available. Make a string harness for two small paper plates and hang these from the ends of a 30 cm. wooden ruler. Support this ruler at some point between the two plates such that they balance. Mark this point and drive a nail support through it. Work this nail so that the ruler swings freely on it. This can be supported across the top of a sand filled plastic dish-soap container, cutaway on the edges. (See Figure 3). Shirt buttons can be placed, one at a time, into the left pan. The leaf is in the right pan, and its weight is determined as being the number of buttons required to once again balance the plates.

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* Metric system abbreviation for centimeter.

Figure 4. Equal-Arm Balance

After each child has completed his histograms of each of the variables chosen for study, look at the data collectively. Separate the histograms into groups by the type of variation measured and post these where they can be examined by the class. Again pose the questions as to who had certain extremes of each variation, such as longest leaf.

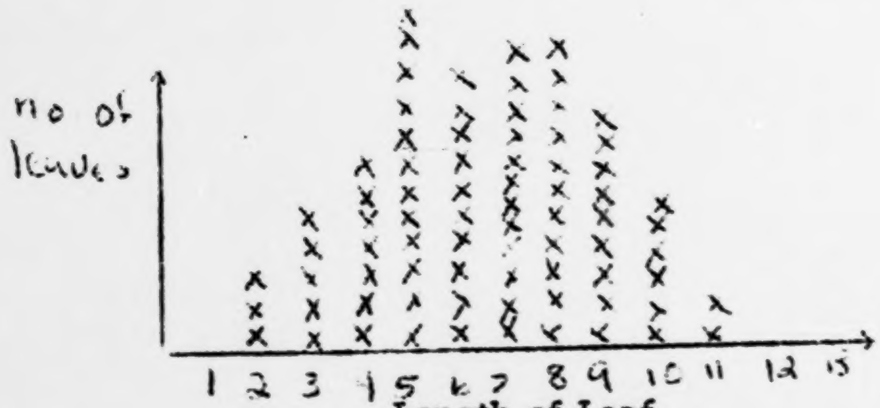
Part 3. Graphing Composite Histograms.

Is there some difficulty encountered in searching each graph for data? If so, how might it all be re-ordered to facilitate answering questions about the range in value of a particular characteristic? Would it be helpful to make one large graph for the entire class? This would eliminate examining each graph independently when a question is posed. Remember, only similar data may be combined to make a composite graph.

Prepare large graph outlines for each variation either on the board or on a sheet of paper. For a class of thirty students, collecting one plant each, a graph with 50 units on the vertical axis and 25 units on the horizontal should be sufficient for any variation measured. These graphs will not contain any information. The figures will be registered on the graphs by each individual child.

Colored chalk or pencils could be used by the children when transferring information from their individual histograms to the class composite histograms. Line up the colored chalk or pencils. The first piece of chalk or the first pencil is used by the first child and replaced in its position. The second piece by the second child and so on. In this way each child can see his contribution to the composite graph.

Below is a histogram representing data collected by several children for leaf length. Similar composite graphs may be made for leaf width, area, weight etc. A very significant variation is that of leaf number per plant in some species. This of course can only be graphed by the class as a whole and might be done at this time.



Length of Leaf

If there is sufficient data for each variation measured, perhaps the students will see a pattern developing among the several graphs. A line following the trend of the column will make this pattern more evident. What is the shape of this pattern?* Any plant collection may be biased however because of technique variances and environmental influences, thus the curve may be skewed (not symmetrical). It is important, though, for the children to realize the tendency for most things measured in the biological world to fall into the middle of a continuous range regardless of what is measured.

Following are some questions which could be asked with reference to the above graph. Similar ones may be asked of your class relative to their graphs:

"What appears to be the most 'common' length for the leaves according to our sampling? What are the second, third and fourth most common lengths?"

"Can we say our composite graph tells us there are positively no plants with leaves of a length less than 2 inches or more than 11 inches?" Such an assumption cannot be made no matter how large a sampling was taken. They can assume that it would be 'uncommon' to find a leaf of either of these lengths within the area their sample was taken from.

"Can we assume we would get the same resulting graph if the same size sampling were taken from another area?" Environmental factors and hereditary factors must be considered before answering such a question. If the area has the same environmental factors of soil, light, temperature etc., and if the plants of this area evolved under the same conditions as our study plants, the resulting graph might well be the same as ours.

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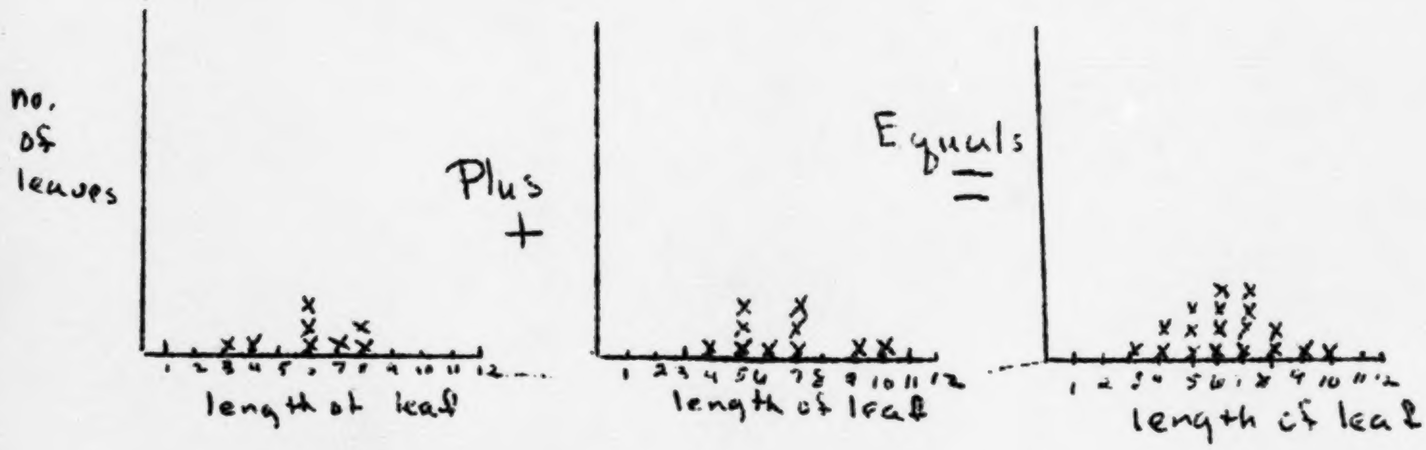
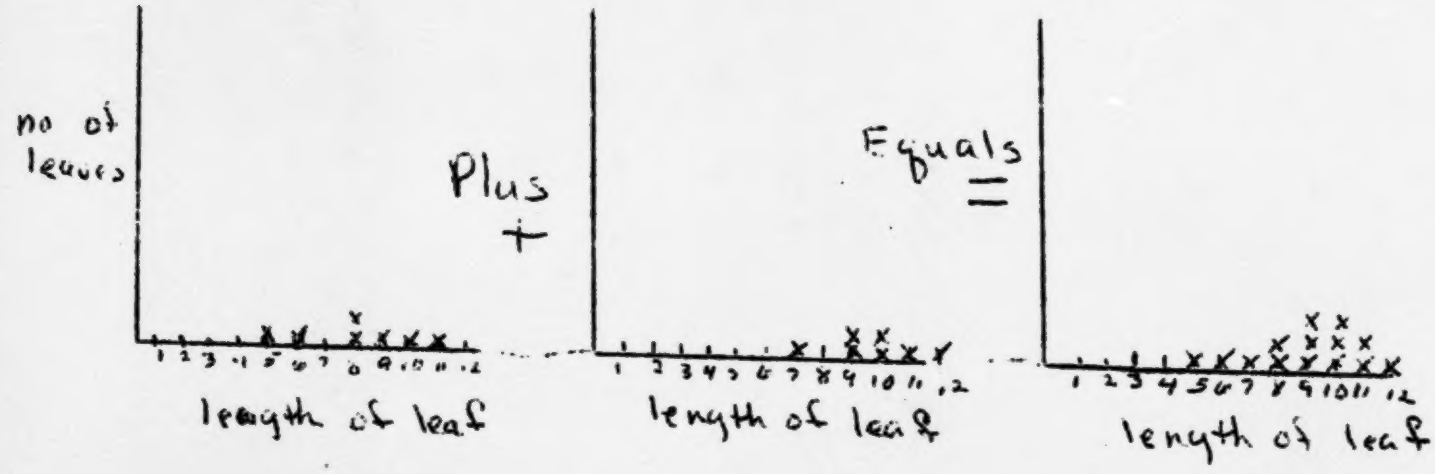
* Measurement values of the variations in characteristics within a species are found to be normally distributed. This means that they tend to cluster about a central point. An ideal curve would be bell-shaped and symmetrical.

"If we measured these variations in another plant species, would we get the same results?" They should now see that the shape of the curve (bell shaped) should be the same but the curve might occupy a different position on the graph.

To firmly establish the idea of sample size as it influences the results, have the children look at their individual histograms. Do they see any bell-shaped curves on these individual histograms? Probably there won't be such a curve on these individual, one-plant histograms. Can they explain why? Have the children circulate, locate and try to combine 2 or 3 histograms so that a symmetrical or bell shaped curve results. Possible small graph combinations are shown below. Following are questions which could be asked about these graph composites or about those made by your class.

"What is the smallest number of leaves in these several composites which resulted in a bell shaped curve?" If the questions asked about the class composite graph were asked of the small composite graphs, would the answers be the same? If not, which results are the most valid, those of the class composite or those of the small composites? If the results are the same, could we say a sampling of this smaller size could replace the large class sampling? Could it be this result was "lucky"? Do you think it is repeatable?"





Related Studies (optional)

As mentioned in the background information of this lesson, variations in size, weight and leaf number, etc. may be accounted for if heredity and environmental conditions are considered.

Hereditary changes are normally not measurable within one generation. However, a size range and frequency distribution (for plantain) has now been established. These data could be used as a basis for a study of heredity in a population.

Environmental influences may be studied by correlating the individual histograms with the location of the plants on the large area map. Tests on the environmental factors can be made at these locations. Procedures for testing several environmental factors are found in E.S.C. lessons on "soil acidity and alkalinity" and "soil moisture". The effect of varying amounts of light intensity on plant growth may be discovered without necessarily running tests. See if there are plants located in areas shaded by buildings or bushes, and note the leaf length, leaf number, and plant weight of these. Compare them with similar figures taken on those grown in continuous sunlight.

Following are some possibilities for graphs resulting from measurements of environmental conditions. Methods for the measurement of these factors can be found in biology field guildes.